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The Branner Geological Library



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RECOMMENDATIONS OF THE PRESS.

The author is well known as an accomplished scholar, and an enthusiastic devotee of the science of geology, and this contribution to the geological history of Tennessee from his pen will be gladly received.—*Nashville (Tenn.) Banner*.

The name of Dr. Currey is familiar with most of the people of this State, as an industrious student of the Natural Sciences. This contribution is plain, short and practical. To the man of science, the practical miner, and the farmer, it will be of great service. We are pleased to see any exertion especially on the part of our citizens to develop and bring to light the hidden treasures of our favored State.—*Nashville (Tenn.) Patriot*.

The book will be found an interesting and valuable description of the geology and mineralogy of our State, and has been much complimented by the press abroad.—*Knoxville (Tenn.) Register*.

We have recently received this excellent work and cannot give it higher terms of praise than we have done by copying, as we have, on our first page, a long extract, to which we would invite attention, on account of the practical usefulness of the same, both to the farmer and mechanic.—*Bristol (Tenn.) News*.

On account of the practical usefulness of this work, both to farmers and mechanics, it should be in every family. It is small, clear, comprehensive and cheap.—*Brownlow's Knoxville Whip*.

Every man in East Tennessee should have a copy. We know not the price, but let it be anything in reason, land owners and cultivators of the soil would find it money well spent.—*Maryville East Tennessean*.

A valuable aid in the development of Tennessee's vast resources, and interesting to any one who is identified with her prosperity.—*Southern Clarion, Cleveland, Tenn.*

The marble, iron, copper, gold and coal of this section (East Tennessee) are noticed at considerable length and in an interesting manner.—*Presbyterian Witness, Knoxville, Tenn.*

Currey's Geology of Tennessee.—Some weeks since we published a very interesting and valuable paper *On the Geology of the Copper Region of East Tennessee*, by RICHARD O. CURREY, M.D., late Professor of Chemistry and Geology in East Tennessee University. We have now received from J. A. Rayl, Publisher, Knoxville, a work bearing the above title, which furnishes us a very full report on the general geology of Tennessee. The author has so well fulfilled his pleasurable task, that we shall look forward with impatience to the publication of a work announced by him on the *Geology of the Southern States*, and which will most probably be ready in October next.—*United States Mining Journal, New York*.

Our old citizens remember, many years ago, to have met now and then, "up in the mountains" of East Tennessee, or on the fertile plains of the Western District of the State a pale stripling breaking rocks at the feet of Tennessee's geological Gamaliel, the lamented Troust. The boy ripened into the fully matured man, and the first fruits of a thorough and protracted culture is the modest volume before us. It is but the nucleus around which gems will cluster, until exterior accretion shall result in a product of which a great State may well feel proud.

Indeed there is so much practical information in this little work, that no one can read it without wishing it a place in every library in the country, and we think it the duty of the entire press of our noble State to promote its diffusion. We hope the author will make it accessible to the entire people of the State through book-sellers generally.—*Nashville Journal of Medicine and Surgery*.

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Wm. L. G. W's
Book.

From Lu
To
Young

Mrs M E Walburn

6a
C. F. Branner
April 15, 1900
A SKETCH

OF THE

GEOLOGY OF TENNESSEE:

EMBRACING

A DESCRIPTION OF ITS MINERALS AND ORES, THEIR
VARIETY AND QUALITY, MODES OF AS-
SAYING AND VALUE;

WITH

A DESCRIPTION OF ITS SOILS AND PRODUCTIVENESS,
AND PALÆONTOLOGY.

BY

RICHARD O. CURREY, A.M., M.D.,

LATE PROFESSOR OF CHEMISTRY AND GEOLOGY IN EAST TENNESSEE UNIVERSITY.

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To the Memory
OF
DR. GERARD TROOST,
THE LATE DISTINGUISHED GEOLOGIST OF TENNESSEE,
AND
ABLE PROFESSOR OF NATURAL SCIENCE
IN THE
UNIVERSITY OF NASHVILLE,
MY PRECEPTOR;
TO
THE YOUNG GENTLEMEN
OF THE
CLASSES OF 1847, 1848, 1849, 1850,
IN
EAST TENNESSEE UNIVERSITY,
MY PUPILS;
THIS OFFERING TO THE GEOLOGY
OF
MY NATIVE STATE
IS GRATEFULLY DEDICATED.



PREFACE.

WITH much diffidence the following Sketch is given as a contribution to the Science of Geology. For many years, I have availed myself of every opportunity that presented itself, to become acquainted with the mineral resources of my native State—and for this purpose, several excursions have, at different times, been undertaken. During these explorations, nearly every county in East and Middle Tennessee have been examined, and their Geological character noted, as well as the border counties of West Tennessee. These notes, made by the wayside, have occasionally been published in the newspapers—and more extensively in the *Southern Journal of the Medical and Physical Sciences*.

A series of these articles were published in the *Nashville Banner*, in 1853, for the purpose of inducing the Legislative Assembly, then in session, to provide for the completion of the Geological survey of the State. Such provision was made, and the work entrusted to Professor Safford, of Lebanon.

At the solicitation of many friends, I am led to collect these papers, re-write, and re-arrange them in the present form. It was my intention to have re-published my Geological map—the first edition of which was issued in 1854—and sent it out with this work. With the exception of a general outline map, made by Dr. Troost, and a special map of the Central Basin of Middle Tennessee, by Prof. Safford, it was the first Geological map that delineated the several formations of the State. In many respects, it was imperfect; but as far as it went in its specification of the formations, and in the Geological section of the State appended to it, it was accurate. I have seen many things in it since, which I could have corrected in a new edition; but two reasons, for the present, have prevailed upon me to defer the second edition: the first one is, the labor necessary to have it published elsewhere—no

facilities being afforded for such work at my place of residence; and the other, Professor Safford has published an excellent map, to accompany his First Report, which, by his kindness, I am permitted to obtain for insertion in the present volume. As the map does not differ materially from my own, and as, owing to his more extensive surveys as State Geologist, he has had opportunities for acquiring information not possessed by myself, I do not hesitate to adopt and endorse it.

For the first reason, I am prevented also from presenting many valuable and beautiful local Geological sections, taken from nature. Beginning this work as a series of articles in my Medical Journal, defects necessarily occur in the typography; and having, since the commencement of the publication, changed my original design, the present work is somewhat curtailed in size and matter. I am now gathering material for the publication of a more general work, to be entitled *The Geology of the Southern States*, which I hope to have ready for the press by the first of October next.

R. O. C.

Knoxville, Tenn., April, 1857.

CONTENTS.

INTRODUCTION.

Object of this Sketch; Author's Surveys; Author's Geological Map in 1854, 2; Outline of Mineral Regions in Tennessee, 3.

CHAPTER I.

FORMER GEOLOGICAL SURVEYS.

Analysis of Dr. Troost's Ten Reports, 5; Tribute to the Memory of Dr. Troost, 8; Arrangement of present Sketch, 9.

CHAPTER II.

EAST TENNESSEE.

Geological Sketch, 10; Seven different Strata, 13; Cause of Inclined Stratification, 14. *Mineral Resources*:—

SULPHATE OF BARYTES.

Localities and Uses, 17.

SULPHATE OF LIME.

Uses as a Fertilizer, 18.

SALT.

Labors of the late Joseph Estabrook, 18.

CARBONATE OF LIME.

Varieties of Limestone—Geological Character of Limestone Strata of East Tennessee, 19; MARBLES OF EAST TENNESSEE—1. Breccia, 20; 2. Black Marble, 21; 3. Magnesian Marble, 21; 4. Whitish Variegated Marble, 23; Red Variegated Marble, 23; Rogersville Marbles, Sloan's Quarry, Dr Grant's Quarry, 23; *Banner Marble*, 24.

EXTENT OF EAST TENNESSEE MARBLES.

Marble Companies, 27; Mode of Polishing, 27.

RED ARGILLACEOUS LIMESTONE.

A Hydraulic Limestone, extent and nature, 28.

SALTPETRE.

How Manufactured, 28; Localities, 29; How Formed, 29.

SULPHATE OF MAGNESIA.

Localities, 30; Sevier Rock Houses, 30.

ALUM.

Localities, 30; How Formed in Nature, 31; Mode of Manufacture, 31.

WAVELLITE.

A Phosphate of Alumina, 32.

SILICA.

Its Abundance and Varieties, 32.

TALC.

Varieties, Localities, and Uses, 33.

CHAPTER III.

EAST TENNESSEE, (*continued.*)

GLASS.

Tennessee Manufacture, abundance of ingredients for, 34; Mode of Manufacture, 35.

HYDRAULIC LIMESTONE.

Localities—Analyses, 36; Mode of Burning, 38; Uses, 38.

CLAY OR ALUMINA.

Varieties, 39; Uses—a new metal, ALUMINUM—How Obtained, 40.

MILLSTONE GRIT.

Localities—Uses, 41.

ROOFING SLATE.

Abundance—Localities—Uses, 42.

CHLORITE SLATE, 43.

CHAPTER IV.

ORES OF EAST TENNESSEE.

IRON.

Cranberry Iron Ore, 46; *Brown Hematite*, 47; Extent throughout the State, 48;

ix

Red Hematite, 49; Localities and extent, 50; *Sulphuret of Iron*, 51; Uses and quantity, 52; *Carbonate of Iron*, 52; Localities, etc., 52; *Native Iron*, 53; Cocke county Specimen—Grainger and White Specimens, 53; *Lincoln Specimen*, 54; Table of Tennessee Meteorites, 55.

Production of Iron, and its Consumption, 55; New Discovery in the Manufacture of Iron, 58.

ZINC.

Claiborne Ores, 60; Jefferson Ores, 63; Knox county Ores, 63; Blount Ores, 64; Process of Manufacturing, 64; Uses as Sheet Zinc, and as Paint, 65.

LEAD.

Localities, 66; Varieties, 67; Analyses, 68.

COPPER.

Copper Districts, 69; History of the Discovery, and of the Progress of Mining at Ducktown, 70; Letter from John Caldwell, 75; Ocoee River and Road, 76; Geology of Ducktown, 77; Analyses of Copper from Ducktown, 80; Mineralogy of the Copper Ores—1. Red Oxide, 82; 2. Green Carbonate, 83; 3. Silicate, 83; 4. Black Oxide, 83; 5. Grey Ore, 84, 6. Sulphuret, 84, 7. Native Copper, 84.

Discovery of Copper in other Localities, 85; Assay of Copper Ores, 86.

GOLD.

Localities, 86; Quantity found, associating rock, Gold-bearing Quartz, 87.

SILVER.

Extract from Report of Dr. Troost, 87; Sulphuret of Silver—Probable Origin, 88;

CHAPTER V.

COAL REGION OF TENNESSEE.

Importance of Coal to England, 88; Extent of Coal Fields in the United States, 89; Varieties of Coal, 90; Extent of Tennessee Coal Field, 90; Geology of the Coal Region, 91; Analyses of Coal, 92; Coal in Raccoon mountains, Sequatchee valley, 93; Walden's ridge, Anderson county, Campbell county, Morgan county, 93; Kentucky Railroad, importance of, 94.

Geological Position of the Coal Deposits, 95; Utility of Coal, 95.

Palaeontology of the Coal Measures, 96.

CHAPTER VI.

MIDDLE TENNESSEE.

Three Characteristics of Geological Formations, 98; General sketch of Middle

X

Tennessee, 99; The lower Geological Position of Nashville, 100; Different Varieties of Limestones, 101; Elevated Ridges surrounding the Central Limestone Region, 102; "Silicious Stratum," 103.

Minerals of Middle Tennessee, 103; Alumina, Iron, Tripoli, Fluato of Lime, Sulphate of Lime, Copperas, and Nitre, 104.

Palæontology of Middle, and of East Tennessee, 104; Dr. Troost's Memoir on *Crinoidea*, and Characteristic Fossils, 105; Mastodon and Megalonyx, 105; *Mania* found in Wilson county, 105.

CHAPTER VII.

CRETACEOUS SYSTEM OF WEST TENNESSEE.

How Differing from the other parts of the State, 106; Physical Geography of West Tennessee, 107; Geological Character, 108; Artesian Wells, 109; *Greensand*, 109; Uses of Marl in Agriculture, 110.

Minerals of West Tennessee—Iron, 111; Marl, and its Analysis, 111; Hydraulic Limestone, 111; Lignite, 112; Fire Brick, 112.

Palæontology of West Tennessee—Characteristic Fossils, 112.

CHAPTER VIII.

AGRICULTURAL GEOLOGY OF TENNESSEE.

General Remarks on the Application of Geology to Agriculture, 113; Character of Soils in East Tennessee, 114; Middle and West Tennessee, 115; Use of Marl in West Tennessee, 115; The Wealth of Tennessee, in what it consists, 116; Importance of the *Manufactory* along by the side of the Plow, 117.

SUPPLEMENT.

MARBLE, 121; LEAD, 122; LOOKOUT MOUNTAIN, 123; MINERAL WATERS, 124; *Sulphureous Springs*, 125; Nashville Sulphur Springs, 125—Description and Analysis, 126; *Chalybeate Springs*—Montvale Springs, 127—Description and Analysis, 127; Shelby Chalybeate Spring, Nashville, 128.

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A SKETCH

OF THE

GEOLOGY OF TENNESSEE,

CONTAINING A DESCRIPTION OF ITS MINERALS AND ORES—THEIR VARIETY AND
QUALITY—MODES OF ASSAYING AND WORKING, TOGETHER WITH THE
CHARACTER OF THE SOILS AND THEIR PRODUCTIVENESS.

BY RICHARD O. CURREY, A.M., M.D., KNOXVILLE, TENN.

The importance of Geological observations is based upon their accuracy, and this accuracy can only be secured by actual examination by the observer himself. It is easy enough to compile from the labors of others; but to take the field, compass, hammer and chisel in hand, and search out the character and extent of the various formations of a district of country, *hoc opus est*. But viewed in any respect, whether as occupying the mind and attention while seated in the cabinet, assaying and analyzing ores and minerals, and arranging and labelling them, or pursuing the more arduous, and the more creditable part of the profession, making field surveys for one's own self, studying the various ores and minerals, rocks and soils as they are arranged in the cabinet of Nature, there is a pleasure and a delight unknown in its full fruition but to the votaries of this science. The author of the following pages offers the results of his explorations in this field of scientific research, under the confident belief that if he

adds but one stone in the Temple of Science, he has achieved that which fully compensates for all the labor he may have undergone.

It was my good fortune often to accompany that distinguished Geologist, the late Dr. Gerard Troost, in his geological excursions throughout the State, and to assist him in assorting and classifying the various minerals and ores and fossils obtained during these surveys. Thus during a period of eighteen years, sometimes accompanying Dr. Troost, but more frequently alone, the Eastern and Middle divisions of the State have been traversed in various directions, and in these travels, prompted solely for his own gratification, the author has neither sought nor received one cent's compensation for his labors, either from State, companies or individuals. Many sections of local formations have been prepared which yet remain in manuscript: but in 1854 I published a Geological Map of Tennessee, as the result of these several explorations, which subsequent examinations of new districts enables me to correct.

The following mineral regions are embraced within the limits of Tennessee, all of which, to a greater or less extent, have been examined:

1. *The Copper Region* first developed in the south-east corner of Polk county, but has been found to embrace the entire range of the Unaka Mountains, and may therefore properly be designated as the *Unaka Copper Region*. This region begins at Alabama and extends N. E. through Georgia, along the boundary between North Carolina and Tennessee, and into Virginia. The ore is found associated with the Metamorphic mica slates, quartz and sandstones.
2. *The Gold Region* is limited in Tennessee to Polk and Monroe counties, but there is no doubt as to its connec-

tion with the Georgia Gold Region on the South, and probably with the Virginia Gold Region on the North. The same chlorite slate which accompanies the metal at Coqua Creek may be traced to the South-west, cropping out on the abrupt cliffs which overhang the Ocoee River. The metal is found associated with quartz and chlorite slate.

3. *The Slate Rock Region* along the western declivity of the Unaka mountains extends the entire width of the State, and offers inducements for manufacturing operations as well in slate as in alum and its saltpetre caves.

4. *The Cranberry Iron Region* as it exists in Carter county and those adjoining to the south, and affording the magnetic oxide of iron, yields the best metal in the world. The accompanying pyroxene rocks indicate a continuation of the strata found associated with Gold on Coqua Creek.

5. *The Marble Region*, existing in not less than six different strata running throughout the entire length of East Tennessee, differing in character as well as in color, those near the Unaka mountains, being breccias and primordial limestones, while those through the interior counties being fossiliferous. This region is extensive, and affords as fine marble as can be found any where in the Union.

6. *The Lead and Zinc Region* traceable in one vein from Elizabethton, Johnson county, through New Market Valley, and thence to Blount county, and in another through Powell's Valley, and into Anderson county. The two ores are associated, and are found imbedded in limestone strata.

7. *The Appalachian Iron Region*, extending along the eastern declivity of the Cumberland Mountains from Virginia to Georgia, affording the scaly oxide of iron or red hematite.

There is also another variety, the Carbonate of iron found in the counties adjacent to Ky.

8. *The Coal Region* of the Cumberland mountains interstratified with sandstones and shales, and varying in thickness and quality. We need as yet a good and accurate survey of this highly important region, with every outcrop of coal mapped. In the four different directions in which my reconnoissance of this field has led me, I have found such an abundance of coal as would justify the conclusion that coal contained within the limits of Tennessee is inexhaustible, covering the entire area of the Region.

9. *The Silicious Region* of Middle Tennessee, composed of thick strata of flint or chert rocks, and, at an average altitude of 300 feet above the limestone region of the interior counties of Middle Tennessee, surrounds it entirely like a girdle. It is also the region in which the Iron Region of Middle Tennessee is found.

10. *Iron Region of Middle Tennessee*, composed of the hydrated oxide of iron, constituting immense iron banks, and being the source from whence a large portion of the iron of the west is obtained.

11. *The Limestone Region of Middle Tennessee*, noted for its fertility, situated in a basin, surrounded by the Silicious Region, and composing nearly all of the interior counties.

12. *The Marl and Green Sand Region of West Tennessee*, though differing essentially in its geological characters, presents a field as equally interesting as the others from its inherent fertility, and its adaptedness for enriching the worn out fields in the less productive portions of the State.

13. *The Region of Recent Formations*, extending along the Mississippi and to various distances into the interior, composed of fluviatile deposits intermixed with decaying vegetable matter, which has begun to assume a carbonaceous character constituting lignite.

These are the principal Regions of the State, and among them are to be found strata of other rocks; and deposits of other minerals, which will be more particularly noticed in the following pages :

CHAPTER I.

FORMER GEOLOGICAL SURVEYS.

As early as 1831, the General Assembly of the State of Tennessee provided for a Geological Survey of the State. Dr. Gerard Troost, then Professor of Chemistry, Mineralogy and Geology in the University of Nashville, was selected to undertake the work. The duty assigned him was to make this survey with the view of developing the Mineral resources, to make analyses of substances of value, examine the soils in different sections of the State, "with such other remarks as may lead the citizens to an estimate of comparative value and use, as well as to enable them to judge understandingly of its metals and minerals."

No limit was fixed to the duration of the appointment, but he was required to report to the next Assembly what he had done as Geologist, and for this work he was to be allowed \$500. This act was passed after he had delivered a discourse before the Assembly on this subject, of which, by resolution, a copy was requested for publication.

In 1833 he was continued in office for two years, his salary now being fixed at \$500 per annum, and such additional acts were adopted at each succeeding session till 1850.

I am not able to ascertain the character of the first Report, nor when made, unless the discourse delivered in 1831 was so regarded.

The second Report in 1833, is noticed in the Journals of the House, an extract only being given by the committee on Statistics. The subject of the report appears to have been a description of the Coal Formation.

The third Report in 1835, contains, 1st, an account of the coal formation, with a map, as it exists in the Cumberland Mountains; 2d, marl, the soil of part of Middle Tennessee, and an account of some of the iron ores, with statistics of Forges and Furnaces.

The fourth Report in 1837, begins with an outline of the Science of Geology, and then gives a description of the Ocoee District. A note is appended containing a list of the organic remains found in the Mountain Limestone of Tennessee.

The fifth Report in 1839, gives first an outline of the Geological formations in Tennessee, with their characteristic fossils; second, a particular description of Cocke county, its minerals, soils, streams and vegetation, and the meteoric mass of metallic iron found in that county; third, additional investigations into the iron ores of the State, and fourth, a notice and analysis of the silver ore (sulphuret of silver,) found in the bed of Caney Fork on Cumberland Mountain. This Report also contains an appendix, giving a list of the organic remains.

The sixth Report in 1841, contains, first, an account of the changes that had recently been introduced into the nomenclature of the Science; second, a general description of Sevier county, and third, an account of the roofing slate of East Tennessee, and of the abundant materials for the manufacture of alum, sulphate of magnesia, and saltpetre, concluding with the analyses of several Mineral Springs in various parts of Middle Tennessee.

The seventh Report in 1843, contains, first, descrip-

tions of the counties of Davidson, Williamson, Maury and Perry; second, a more minute description of the green sand in McNairy county, and third, a list of some of the animals in the State. In a supplement to this Report, attention is directed to the lead and zinc ores in East Tennessee.

The eighth Report in 1845, describes the most advantageous routes for the construction of the Nashville and Chattanooga Railroad, especially with reference to the abundance of coal, alum, iron, limestone and sandstones on these routes.

The ninth Report in 1848, contains, first, a description of Jefferson county, and second, an account of the zinc ores of Tennessee.

The tenth Report in 1850, was purely scientific in its character, giving a short account of the Crinoidea of the State. It was not published.

Such has been the interest awakened in regard to the mineral wealth of Tennessee, that these reports are in great demand. But as no care was taken to preserve them, they are scarcely to be found complete. But while it may be admitted that they do not in every instance point out the exact localities of minerals and ores, but deal rather in generalities; yet every succeeding Geologist will find, as much as they may seem disposed to underrate the labors of this man of Science, that his Reports will be sure guides to further discoveries, and we will be much mistaken if they are not oftener consulted than their author receives credit. If properly compiled and edited, no better text-book on Geology could be placed in the hands of a Tennessee student.

They evince clearly the industry and the scientific attainments of the man to whom the survey was entrusted.

We see him, in the infancy of the science, entering upon the examination of an unexplored field, as varied in its geological formations, minerals and fossils as in its climate and scenery. We see him toiling alone, at one time, along the rugged mountain sides, then winding his way up the quiet and shady valley, penetrating the inmost recesses of the earth, exploring the plains and the fields, and developing the mineral resources of the State, and for what?—not surely for the pittance granted him as compensation for his labors, but through his innate love for the noble science which he had espoused. From 1831 to 1850, his exclusive study was the soil, the rocks, the minerals, the plants, and animals, and especially the fossils of Tennessee, musing alone upon these ancient inhabitants and reading in them the history of the dark ages of the earth. The Cabinet of Natural History, perhaps second to none in the Union, which he collected and arranged, composed in a great degree of the results of his own explorations, especially in organic remains, is a monument to his industry and scientific knowledge. It marks at present the spot where he labored. But there is also due to him a monument of *Tennessee* Marble to mark the spot where he now rests from him his labors.

During the Session of the Legislature in 1854, Prof. J. M. Safford, of the University at Lebanon, was elected Geologist of the State, and his first Report will be made during the present winter, (1855.)

With this synopsis of what has been done for the development of our mineral wealth and agricultural interests, I will proceed to set forth, as briefly as the subject will admit, what remains to be done to advance the State to the position which her resources and advantages justly entitle her.

My subject will lead me to an examination of the geological formations of the State. Taking up these, therefore, in the order in which nature has placed them, I will endeavor to trace out the extent of each—the minerals found in them—their adaptation to agricultural interests—and their economical relations in every respect. The great length of the State, compared with its breadth, causes it to partake somewhat of the peculiar formations of each State by which it is surrounded. And as it is divided by natural boundaries into three great divisions—it is a singular fact that these lines also serve as lines of demarcation between its principal geological formations. These, in the order in which they are found, embrace :

1. The unstratified, granite rocks—Smoky Mountains.
2. The stratified Metamorphic rocks—Smoky Mountains.
3. Lower Silurian—East Tennessee and Nashville.
4. Upper Silurian—Middle Tennessee.
5. Old red sandstone, or Devonian—Cumberland Mountains, East and Middle Tennessee.
6. Carboniferous system—Cumberland Mountains.
7. Cretaceous system—West Tennessee.
8. Alluvium—Mississippi River.

It will thus be seen that there is a regular order in the formations from the old to the more recent, and we shall, in our remarks, examine them as we have found them, in each grand division of the State.

CHAP. II.

EAST TENNESSEE.

Geological Sketch.—There is not found in the Union a more interesting field of the same extent for geological observation than is afforded in East Tennessee. This is true,

not only with reference to the vast numbers of useful minerals imbedded in its strata, and the great quantity of some of them, but also to the complicated arrangement and peculiar character of its rock strata.

In describing, therefore, the formations existing here, and their economical applications to the wants of society, I will begin at a point in the State line on the Smoky Mountains, where it intersects with the Georgia line. From this point draw a line in a N. W. course to Knoxville, thence N. E. to Tazewell, thence N. W. to the Cumberland Gap, and every important stratum will be passed over. On this summit of the Smoky Mountains there are to be found the primordial rocks, consisting of granite, gneiss, mica slate, talcose slate, and quartz rock, containing imbedded crystals of actynolite and garnet. These primordial rocks are not traceable exactly on the boundary line between this State and North Carolina, but sometimes deviating to one side and then to the other. Dr. Troost, with whom I had the pleasure in 1839 of tracing out a portion of this line of demarcation, thus describes these strata in his fifth Geological Report :

“In Carter county the primordial rocks are found ten or twelve miles west of the line; the whole of Roane mountain is composed of granite rocks. The primordial mountains then diminish, and about the head waters of Indian creek are no more to be seen in that part of Tennessee. The State line then runs over the grauwaacke formation or group, till near Wolf creek in Cocke county, where the primordial rocks again enter Tennessee. The high ridge of the great Smoky mountain is granitic till about the entrance of Tennessee river into Monroe county, where the grauwaacke group again makes its appearance, continuing along the Unaka mountains to M'Minn county. Here again the primordial rocks enter the State, and continue on to Amoe river, where they are replaced again by the grauwaacke group.

“Towards the east of the high ridge of the Appalachian chain, the primordial rocks generally prevail. This high ridge which separates these formations and which contains in its limits the

highest mountains of the United States, is sometimes composed of granite and gneiss as Roane mountain; sometimes of a granite, which contains talc and chlorite or protogene; sometimes of a talcose rock containing actynolite. It contains also some veins of magnetic oxide of iron, as the Cranberry ore in Carter county, which is associated with *Pyroxene Sahlite*, as in some of the Swedish iron ore—or is not associated with any other mineral, as in Cocke county."

Where we begin our reconnoissance, they cross the mountain, and on the western descent we soon enter upon a series of sandstones and shales and slates of a primitive or metamorphic character. These strata are found to possess an inclined position, the dip being inwardly S. E. to the centre of the mountain, giving the appearance to the primordial rocks, which they actually do, of overlying these stratified rocks. The dip of these strata being to the E. S. E., the strike or course of the upturned edge is from W. S. W. to E. N. E., observing the general direction of the mountain range. But continuing our descent to the west, when we have reached the base of the mountains, we come upon a series of strata belonging to a more recent date, and affording the characteristic fossils of the Silurian period. These consist of various limestones with interstratified shales and sandstones. And as a general rule, if we start from a point near the Frog Mountains on the Georgia line, and take an E. N. E. course, we may trace out the line of separation between the Metamorphic slates of the Unaka group, and the limestones and other strata of Silurian formation. Thus as we continue our course to the N. W. from this mountain range, we come next upon a stratum of limestone composed of fragments of several shades of gray and black, with white veins, cemented together with the same substance, forming a beautiful breccia marble, then to a hard magnesian limestone and then successively over the uplifted edges, and at right an-

gles to the course, of each stratum, till we have passed about five miles to the N. W. of Tazewell. To this point, each stratum of rock, whatever might be its character, is found to possess similar dips and courses, the angle of inclination being about 45 degrees—unless in a few localities where silicious veins have evidently been forced up through the disrupted rock strata. But a new arrangement presents itself at the point alluded to. As it is approached the strata are found to become less inclined, until at last they have assumed the *horizontal* position. This *anticlinal* axis is about three miles wide, and composed of a hard Magnesian limestone, very fully intermingled with chert rock; in fact, this latter imparting to the former quite a silicious character. The strata to the N. W. of it dip in an opposite direction—gradually inclining to an angle of 45 degrees and more, until they are lost under the Cumberland Mountains.

This axis and these opposed strata, possess the same course as those previously described. To illustrate this, take a book and, partially opening it in the middle, place it upon a table on its edge, the horizontal back will represent this anticlinal axis, and the leaves, the strata inclined against each other. The strata on each side of this axis are identical in every respect. It may be traced from the base of the Cumberland Mountain to the North of Clinton in an E. N. E. direction into Virginia. The stratum which composes the axis is found in several other localities through East Tennessee. I have found it in some places so disintegrated by the washing out of the limestone that the mass which remained, consisted almost entirely of white sand. As yet I have discovered no traces of organic life in it; but its character may be readily determined by its crystalline disposition, there being observ-

ed frequent minute rhomboidal crystals, either projecting or being washed out and leaving the same regular cavity.

In addition to this axis, several others are found, but generally they are local, limited in extent, but nearly all of them are composed of the same stratum. There is one about 15 miles to the west of Knoxville, in which the opposing strata are found on opposite sides of a narrow valley, each dipping outwards, and tending to unite by an imaginary line about mid-way of the valley. Another limited axis is found on the north of Clinch river; the strata here in fact presenting quite a disturbance, twisted and broken up in various places. At the Chattanooga quarry, and in the Lookout range, there is also a singular distortion in the strata. The quarry at Chattanooga, and the strata composing the mountain dipping to the south-west, and of course lie inconformably with other strata in towards the Raccoon mountains. As the greater number of these axes are composed of this hard magnesian limestone, with chert or silicious interstratifications, it may be regarded as the lowest or oldest member of the silurian rocks in East Tennessee, and that it lies immediately upon the Unaka slates and shales.

Its position with reference to the other strata of East Tennessee is in the following order :

1. Unaka granite, gneiss, mica slate, quartz rock and sandstone.
2. Aluminous slates and talcose slate.
3. Magnesian limestone with veins of chert or silex.
4. Magnesian limestone with semi-crystalline veins of calcareous spar.
5. Blue fossiliferous limestone.
6. Red and greyish argillaceous limestone interstratified with hydraulic limestone.

7. Shales and sandstone underlying the coal measures of the Cumberland mountains.

These seven different strata may be passed over at several points in passing along our line of reconnoissance. And the casual observer would overlook the regular order in which they invariably occur. But though there are only these seven peculiar strata, yet there are not less than fourteen such series, making altogether through the valley of East Tennessee not far from forty strata of rock. What caused this disruption? and how is this regularity obtained? We may imagine the rock strata of this whole district once to have possessed a horizontal position, and violent subterraneous action, being exerted in right lines, in a N. E. and S. W. direction, broke up and elevated the strata all along that line where the force was expended. We can suppose this force to have been exerted whenever one series of rock changes for another, and to have been of just that degree to have elevated the strata to an inclination of 45° , thus producing in fact a succession of *faults*, to speak in the language of miners.

Now to solve this problem of their formation, we have but to cast a glance at the physical configuration of the country. Here is a valley, bounded in on the east and west by parallel ranges of mountains of different geological periods, yet the origin of both attributable to violent subterranean action. The Unaka mountains on the east consisting of the primordial rocks, of course are readily admitted as being beneath the fossiliferous strata of East Tennessee, while this lies underneath that of the Cumberland mountains on the west. Now how is it that these Unaka granites and slates are tilted up, and apparently reclining upon the limestones of the valley? This can be only explained on the theory of these faults by local ac-

tion. They do not present the appearance of being disrupted in that way to produce similar strata on each side of the line of action, for then there would appear a succession of anticlinal axes wherever the force was expended. Neither are there any synclinal axes of any extent to be found, setting at rest any idea as to a depression at any point opposed to the force of elevation. This force then acted in such a way as to break the strata and elevate one end of the fragment, while the other remained stationary, and elevating it too to that height that the adjoining fragmentary strata would seem to underlie it. Then again the Cumberland range, constituting an immense coal field, now elevated to a height of more than 1,000 feet above the level of the country, doubtless was once an extensive inland lake, in which all the animals and plants of the carboniferous era lived and flourished, extending from the interior of Alabama to New York. But at the time of these volcanic disruptions, the bed of this lake was elevated, it may be, gradually, to its present altitude, the waters being drained off, and an immense coal field provided for the benefit of man, the last great act of Creative Power.

Thus the mountain ranges on either side, as well as those of less altitude in the valley, and the valley itself, with its streams and rock strata are all parallel, possessing a N. E. and S. W. course.

Observe moreover the uniformity with which the members of each series succeed each other. Thus supposing we indicate the above strata by figures, we have in one series 4, 5, 6, 7, in the adjoining 4, 6, 7, in the next 4, 5, 6; but never any reverse order as 7, 6, 5, 4. This regularity is of decided advantage, especially in those strata which can be applied to the wants of society. It enables

the quarrier to trace out a stratum, or the miner to sink shafts without an useless expenditure of time and money. Two instances may be adduced. The strata, mica slate and quartzose sandstone with gossan in which the Copper of the Ocoee District is found, partake of this same general inclination, and a direct E. N. E. course. The miner therefore reckons his distance for sinking his shaft through the overlying strata, and can readily trace out the course of the vein. And again, No. 4 in the series of rocks is a valuable stratum of Marble which is found to occur *five times* in our line of observation, namely, near the base of Chilhowee Mountain, one mile south of Knoxville—one mile north of Knoxville—north of Clinch mountains, and near Tazewell. Possessing the same E. N. E. course with the other strata, each one may be traced out in its entire length. Take the stratum, for instance, north of Knoxville, and it is the same found at or near New Philadelphia, and near Rogersville. It is supposed by some that there are different strata of different colored Marbles, but I am inclined to the belief that these different colors are but layers of the same stratum, and that the reason why the Marble is found red at one place, white at another, and blackish at a third, is due only to the partial appearance of these different layers. So inexhaustible in quantity, and acknowledged by competent judges at the New York Industrial Exhibition, and at the Capitol at Washington to be of an unrivalled quality, there are only needed the facilities of transportation to render this a source of enterprise and wealth.

Mineral Resources.—The minerals which are to be found in East Tennessee are the following: Sulphate of Barytes, Sulphate of Lime, Carbonate of Lime, Arragonite, Marbles of various colors, Nitrate of Lime, Sulphate of

Magnesia, Magnesian Carbonate of Lime, Alum, Wavelite, Silica, Talc, Chlorite Slate, Hornblende, Garnet, Felspar, Porphyry, Mica Slate; and of ores, we have Magnetic Oxide of Iron, Hydroxide of Iron, Scaly Oxide of Iron, Native Iron, Arsenical Iron, Sulphuret of Iron, Carbonate of Zinc, Sulphuret of Zinc, Sulphuret of Lead, and Black Oxide, Red Oxide, Green Carbonate, Silicate, Grey and Yellow Copper Pyrites and Native Copper, Gold, and Silver.

I will describe each of these in the order in which I have named them.

SULPHATE OF BARYTES.

In many localities, sometimes alone and always associated with Lead, is to be found a heavy rock of various colors—white, yellowish, blue, red and brown. It is the heavy spar, or sulphate of Barytes. The white variety is used for grinding up into a white paint, and probably the red, brown and blue would answer for the same purpose. As a paint, it affords rather a dull earthy lustre, and soon tarnishes. It is much used for adulterating white lead, and when this pigment does not give a glossy smooth coat, it may be presumed to be more or less adulterated with this mineral. Specimens have been obtained from the following localities: the *blue* variety from Sullivan co., near Kendenet's Creek; yellowish crystallized variety, from Powell's Valley below Tasewell; reddish white from Roane county, and a pure white variety from western Blount county. This mineral may be distinguished by its weight.

SULPHATE OF LIME,

Or Gypsum, is one of those minerals whose importance

causes it to be sought after both in Agriculture and the Arts. In our own State we only find it crystalized in limestone rock ; but being contiguous to the Plaster-basin or Salt region of Virginia, it is readily obtained from thence for agricultural purposes. It has been supposed that the salt series of rocks extended into our own State ; but, though numerous borings have been made, as yet nothing has been obtained to compensate for the labor bestowed.—Several of our strata, especially those ranging from Anderson county to Virginia, belong to that series of rock which in New York embraces the Saline Springs, as at Salina, N. Y.

The Plaster is most generally found in basins, of which the great Paris basin is a noted instance. Between Abingdon and the Tennessee line, the Va. and E. T. Railroad passes through such a basin, and its importance on the completion of that road is incalculable.

SALT.

Many attempts have been made to obtain salt at various localities. This has been attempted by means of borings to considerable depth, and though the waters, which have come to the surface through them, have been of a saline character, yet so far of insufficient strength to reward for the labor bestowed. In 1838 we visited a boring which was being made some ten miles south of Kingsport, and though salt-water was reached, yet no benefit was derived from it.

The most extensive operations yet carried on in East Tennessee were performed by the late Joseph Estabrook, whose untiring energy and confident expectations, based as they were upon his scientific explorations, gave hope of success. But just as he was ready to begin the evap-

oration of the water, he departed this life. He was for years engaged in sinking his augurs, and after passing through successive strata of sandstones, shales, limestones, and even coal itself, he reached, at a depth of some 8 or 900 feet, a stream of salt-water, which he pronounced good. Since his death the works have been suspended. At the point where he sank his augurs, occurs an extensive *fault* or fracture of the stratum, such as we have alluded to as entering into the geological construction of the entire eastern portion of the State.

CARBONATE OF LIME.

The limestone rocks are properly an impure Carbonate of Lime. They constitute the greatest proportion of the rock strata, and differ in purity in different regions. Like the coals, the nearer they are to the granite rocks, the purer are they. Thus we descend in the degree of purity from the primitive limestone, of which the *Parian* marble may be taken as a representative to the calcareous deposits of the later geological periods. The marbles belong to the limestone series, and differ according to their degree of purity. The white granular limestone, sometimes called *statuary marble*, belongs to the primary rocks. Beginning at Talladega, Ala., a stratum of the primitive limestone may be traced in a north-eastern direction to Rome, Georgia, thence to Ellijoy, thence to Murphy, N. C., and thence to the Tennessee River, where the Nantagalee River empties into it. At Murphy there are three strata of different colors—bluish white, reddish white, and white—possessing all together a thickness of nearly 60 feet.

Throughout East Tennessee the limestone strata belong to the Lower Silurian formation, and are uplifted at an angle of 45 degrees—the inclination being to the South-

east. All of these strata, as well as all other rock strata in East Tennessee, may be traced in a N. E. and S. W. direction, except at points where some disturbing force has broken up and contorted them.

These limestone strata present several series, to which reference has been made in the Geological Sketch.

Among these series are found several of *marble* of various colors, from reddish white to black.

These marbles may be classed according to their geological position, or their internal characters:

1. The Breccia Marble of the Unaka Range.
2. The Black Marble.
3. The Magnesian Limestone Marble.
4. The Whitish Variegated Marble.
5. The Reddish Variegated.

We might have placed first in this classification the snow white marble of the *eastern* declivity of the Unaka mountains, but prefer confining our remarks to those in our own State. We have consequently made our classification according to geological position, and defined each by its physical characters.

So uniformly do the rock strata preserve a N. E. and S. W. direction that it is easy to trace out one of these strata of marble almost through the entire length of East Tennessee. Thus the stratum which is to the North of Knoxville is on a line continuous with that north of Rogersville.

1. *Breccia Marble*.—Dr. Treost in his Third Report announced the fact that "some parts of East Tennessee contain beautiful varieties of calcareous breccia," and in his Fourth reiterated the fact, "I have seen there (East Tennessee) breccia marble which surpasses any that I know." He directed attention to no specified locality.

During my researches through East Tennessee, I have examined several strata of these Breccian limestones in the counties of Blount, Monroe, Sevier and Cocke. The strata are all along the western declivity of the Unaka mountains, and observe the same general direction and dip as the strata of East Tennessee, and being thus situated, the extent of it from Georgia to Virginia may be readily and safely conjectured. Its thickness may be estimated at seven hundred feet. A specimen before me from the West Fork of Little Pigeon River, Sevier county, is of fine quality and dark colors. Its angular fragments are cemented together by fine whitish veins. Another specimen from Citico creek, Monroe county, is composed of angular fragments of limestone of several shades of black and grey, with white veinings. As the lines which define the various fragments are perfectly distinct, the veins are seen to cross from the one to the other without interruption. The stratum is quite thick. It readily admits of a fine polish.

Another marble from the vicinity of Cleveland possesses such a resemblance to the foregoing, a black ground, with numerous white veins, that it may be regarded as a continuation or spur of the foregoing.

2. *Black Marble*.—In connection with the foregoing stratum is a stratum of uniform *Black Marble*. The texture is firm, grain fine, and it admits of a smooth and shining polish. At Dandridge this stratum of black marble is quite thick, and much used. It is easily quarried, and being on the head waters of the French Broad may be readily shipped to market.

3. *The Magnesian Limestone Marble* constitutes, as we remarked in our geological sketch, the lowest stratum in the valley of East Tennessee. It composes the stratum

which forms the anticlinal axis of Powell's Valley, and is found as one of the members of the many series which go to make up the rock strata of East Tennessee. It is of a greyish white color, very compact, and though not susceptible of as fine a polish as other varieties, yet will make a fine building stone. It is this stratum which lies underneath the city of Knoxville, extending from the river to the vicinity of the depots, being about 2000 feet thick.

Whilst in the limestones of Middle Tennessee are found numerous beautiful crystals of magnesian carbonate of lime, in East Tennessee many of the entire strata of rock are composed of this magnesian carbonate. The reddish colored veins which are found so constantly intersecting the blue limestones, the variegated marbles, and the red argillaceous limestone, is the magnesian carbonate of lime. It occurs in large strata throughout East Tennessee. It is very hard and difficult of being burned into quicklime. It has been believed that the existence of magnesia in the limestone of any district, is an indication of sterility, magnesia being supposed to be hurtful to vegetation. Facts, however, do not support the belief.

There is a stratum of chertz limestone interstratified with the magnesian limestone of East Tennessee, which presents some striking characteristics.

1. It presents the appearance of a vein thrown out between the layers of limestone, imparting its character to the contiguous rocks, and infiltrating itself into its fissures and seams. The city of Knoxville is built upon this magnesian limestone, and these chertz veins are found at Stony Point, near the mouth of 2nd creek—the Rabun Gap Road being cut through it—also near the mouth of 1st creek. Another stratum is found on the bluff overlooking Flag pond, through which Gay street is cut. Its presence

may be supposed wherever the surface of the ground is covered over with fragments of flint rock.

Some specimens from the vicinity of Knoxville present the appearance of nodules of chert cemented together with calcareous matter. The chert nodules were evidently hollow, as the calcareous cement apparently fills up the cavity. Though hard, and the component parts possessing different density, yet it may admit of a polish.

4. *Whitish Variegated Marble*.—This variety, and the succeeding might properly be classed as one, as they lie contiguous to each other. This is the stratum which composes the bluff at Mecklenburg, the residence of Dr. J. G. M. Ramsey, and also that near the residence of Col. John Williams, 2 miles east of Knoxville. It is white, with numerous red specks interspersed through it. It is used for tombstones and slabs, and is extensively worked in Knoxville.

The same stratum is found on the south-side of the river, and of course might be discovered to the N. E. or S. W. of these points. We have traced it through New Market Valley.

5. *The Reddish Variegated Marble* is the most abundant, and that which has been most extensively quarried in East Tennessee. It is of various shades of red and white, with greenish specks, and being composed, in a great degree, of crinoideal fossils, it presents a beautiful appearance when polished. The stars and the stems of the encrinites are quite distinct. Some specimens are quite uniformly red, others red and white in a heterogenous mixture; others again are red and white in wavy lines, whilst others are reddish with white crystalline veins, anastomosing like net-work throughout the entire mass. These strata are thick and easily quarried.

The Rogersville marbles were those which were first opened. As early as 1838, in company with Dr. Troost, we examined this quarry, and information given as to its extent and value. The specimens obtained at that time, polished for and presented to us by Dr. Walker, of that place, though handled by hundreds, yet preserve their original polish. We do not know the extent to which these quarries have been opened, nor yet what success the companies met with. They have now a better outlet by Railroad than they ever possessed, and it is believed that the works will be continued more successfully. The blocks for the National Monument, at Washington, came from these quarries. Some are composed of innumerable small white and red grains, with an occasional greenish speck of chlorite, while others are deep red, intersected with veins of white magnesian carbonate of lime. In these quarries there are various shades of red, some are almost pure white.

Mr. Sloan's quarry, two miles east of Knoxville is probably on the same stratum as the Rogersville quarry. The marbles are of the same character. They are much used in Knoxville, and from this quarry was obtained the columns for the chambers of the Capitol.

Mr. Sloan, under charter from the Tennessee Legislature, is now organizing a company for the more productive working of these quarries. He has a contract to furnish marble for the interior decorations of the Ohio State Capitol.

Dr. Grant's quarry, 22 miles from Knoxville, on the line of the Railroad, is a continuation of the same stratum, and many specimens have been obtained, filled with fossils, variegated, of an impure reddish white, and black with white veins.

Dickeson's quarry, near Knoxville, is on the same stratum, and work will soon be begun for the manufacture of mantels, slabs, tombstones and monuments.

In this quarry slabs possessing a yellowish cast, have been obtained; also a variety which, for the regularity of its stripes or bands of white and red, Dr. D. denominates the zebra marble, or, as fossil encrinal stems are found in it also and resemble stars, a more suitable name would be the *banner marble*.

There is another and different stratum of marble one mile south of Knoxville, on the Maryville road. This stratum is about 300 feet thick. A lease has been taken on the property by Prof. M. W. Dickeson, of Philadelphia. It differs in no respect from the foregoing quarries.

There is also a stratum of these variegated marbles at New Philadelphia, a continuation of the last mentioned.

Another stratum is to be found north of Clinch mountain, and may be traced through the entire length of that valley.

There is a blue compact limestone, interspersed with white spots, the internal cast of a fossil shell, found in Hamilton county, on the line of the Nashville and Chattanooga Railroad. It will make a beautiful marble.

There is also to be found on the line of the Nashville and Chattanooga Railroad, not far from Lookout Depot, a stratum of reddish variegated marble—a specimen of which we have had polished, and proves to be of good, we may say excellent, quality. The strata examined presented a darker shade of red than is to be found in the generality of our East Tennessee marbles.

The building stone found in Chattanooga, when dressed will present a fine appearance, but being largely mixed with earthy matter, it will not admit of a fine polish. One

of the specimens is of a soft yellowish color, intersected with reddish veins of carbonate of lime. The quarry is a fine one, and supplies the city.

Similar to the foregoing, though containing in addition a large per cent. of silicious matter, is a stratum of limestone from the lands of Col. D. P. Armstrong, near Knoxville. This is the same stratum which has been opened on the lands of Mr. Moffett, below the city, and which has supplied the stone for the building of the pillars on the Rabun Gap Road.

In the same quarry is a more compact stratum which affords a smooth conchoidal fracture, and the reddish seams, through a greyish white ground, present a beautiful appearance in the polished specimen. Its compactness requires it to be worked with care.

EXTENT OF THE EAST TENNESSEE MARBLES.

To the inquiry which has been frequently made of us, we have replied that the marble strata of East Tennessee are inexhaustible. Supposing that every stratum was placed in juxtaposition it would form a band extending from Carter to Hamilton, 200 miles in length, and not less than 3000 feet thick.

When the Hawkins county block was carried to Washington City to be placed in the National monument, the committee who had in charge the extension of the Capitol was so pleased with its appearance, that they sent out an agent to ascertain whether it could be obtained in sufficient quantity for the purposes of the Capitol.

As yet but a small proportion of that quarried has been worked up at the place. Mr. Sloan himself freighting to Nashville the rough blocks, to be modelled in his extensive establishment for the State Capitol, and for sale.

Ere long, however, two companies, in addition to the yards already established here, will be operating in their respective quarries. Mr. Schmidt, of Knoxville, is engaged in preparing mantles, slabs, and monuments, for sale, and meets with encouragement from the citizens at home and abroad. For the excellence of his polished and varied marbles he obtained the premium at the last exhibition of the East Tennessee Agricultural Society.

The Dickeson Marble and Zinc Mining Company will soon go into operation, having taken leases, and made purchases of several strata at various points.

The company under the management of Mr. Sloan, called, if I mistake not, the *Ætina* Mining and Manufacturing Company, is already organized, and will soon have in readiness their steam machinery, on the lands of Mr. Sloan, near Knoxville.

By reference to our Geological Map these strata or beds of marble may be seen extending throughout the whole length of East Tennessee.

As numerous applications are made to our masons for polished specimens, and as many own lands on which there is an outcrop of marble, we append a short description of the process for preparing and polishing the marble. After selecting a sound specimen, either saw it, or pick a smooth surface with a sharp steel hammer or chisel. Then in polishing, first wear down the rough surfaces by means of sharp sand and water, by rubbing two surfaces together, or by rubbing it on an iron plate. This process is to be continued by successively using sand of finer quality. Some then rub the surface with very fine emery on a plate of lead, but most generally the smooth surface obtained by the sand is next subjected to a rubbing with *tin-patty*, by means of cloth radders or buckskin

fastened securely to a block. It is a tedious process, and one which requires time and patience.

These strata will doubtless be a source of great wealth to East Tennessee, and the labors of her Geologist could not better be directed than to a special examination of them.

RED ARGILLACEOUS LIMESTONE.

There are several strata of red argillaceous limestone through East Tennessee. A stratum passing through the country one mile north of Knoxville, may be traced to the N. E. through Grainger and Hawkins, and to the S. W. to the Tennessee River. It is highly inclined, in some places being perpendicular, forming a bold projecting escarpment as may be seen near Sinking creek, five miles west of Knoxville. The rock has a dull and earthy lustre, soft and readily broken.

It is interstratified with a whitish stratum, and has been supposed to possess the properties of an hydraulic limestone, and has been burned for that purpose. Further trials will be made with it.

This red limestone, when exposed to the air, soon crumbles down and mixes with the soil, giving to it a red color. Deep in the ground, it is quite compact. Reddish white veins of crystalline magnesian carbonate of lime is found tracing it of different thicknesses.

It is most generally found lying underneath the stratum of variegated marble.

SALTPETRE.

Saltetre is manufactured from the nitrate of lime found in caves. This nitrous earth exists as an efflorescence or in delicate needle shaped crystals. In the manufacture of saltetre, which is a nitrate of potash, the nitrous earth

is mixed with wood ashes, and thrown into a hopper. Water being added, a chemical action takes place. The potash takes the place of the lime, and the nitrate of potash passes through in solution. This ley is crystallized, re-washed and re-crystallized.

A cave is found near the residence of John Smith, Esq., 4 miles north of Knoxville, in which the nitrous earth is found.

Several of the rock houses so abundant in the mountainous part of Sevier county, will furnish saltpetre. It is also found in caves in Morgan county.

During the late war, saltpetre was manufactured extensively from the materials found in our caves, and now that it is commanding again a high price, inducements are held out for the investment of capital. A company for this purpose was chartered by the last Legislative Assembly (1855,) and they design, in a short time, commencing operations. The object of the Company is not only to manufacture saltpetre, but also gunpowder. The presence of this nitrous earth in these caves arises from the action of decomposing animal matter upon the limestone rock, the nitrogen of the ammonia, coming from the excrement of birds and animals, being converted into nitric acid, and acting upon the limestone to form nitrate of lime.

Whilst in many countries saltpetre is made artificially by acting upon the carbonates of lime and magnesia, with nitrogenous animal matter, and the refuse plastering of old houses is also preserved for this purpose, we have such an abundance of this nitrous earth in our caves, that it is singular it has not attracted the attention which it deserves.

SULPHATE OF MAGNESIA,

Or Epsom Salt, has a saline, bitter taste. It is usually

found in fibrous crusts or masses, possessing a glossy lustre. It is found in Warren county, in large masses. It is also found in the caverns of Sevier county, not far from Sevierville. It is there found in fibrous masses, filling cavities in the slate rocks. A specimen of that character has been sent me, the internal yellowish being the iron pyrites, the white fibrous crust, the sulph. magnesia, and the slate rock surrounding the whole. To free it of these accompanying minerals it has to be broken into fragments and exposed to the air until decomposition takes place. The entire mass is lixiviated, the fluid evaporated, and as the sulph. magnesia is more crystallizable than the other two, it is only necessary to pass it through repeated washings and crystallizations to obtain it pure for commerce.

There is in Sevier county a remarkable cave, or *Rock House*, formed, as is the case in all other instances, of shelving strata of slate, or of limestone, in which Epsom salts, in quite a pure state, is found in abundance.

Throughout East Tennessee the limestone rocks are a magnesian carbonate. From these also the sulphate of magnesia may be obtained by acting upon the broken rock with sulphuric acid, a combination takes place between the acid and the magnesia, which is crystallized from the insoluble sulphate of lime.

ALUM.

Throughout East Tennessee, the materials for the manufacture of alum exist in abundance. This is found chiefly in the aluminous slate, which is to be found in the Sequatchee Valley, Clinch mountains, and the declivities of Smoky mountains of East Tennessee.

In these aluminous slates are generally to be found iron pyrites, which on exposure to air and moisture is decom-

posed. The iron pyrites is composed of sulphur and iron, and the decomposition consists in absorbing oxygen from the air, and forming sulphate of iron, or copperas. When thus formed the acid sulphate acts upon the aluminous slate, and forms sulphate of alumina. Thus there is formed one of the ingredients of alum. This being a double salt, the sulphate of alumina and potassa, after the decomposed slate is placed in a hopper, it is lixiviated. To this lixivium or lye, a lye of potash, which is made by passing water through ashes, is added as long as the alum falls; it is then evaporated and crystalized. But in the manufactories a long process is carried on so as to free the alum of all impurities. For instance, to expedite the decomposition of the alum slate, it is first roasted and then exposed to air and moisture, for a certain length of time, and the evaporation of the alum lye, when united with the potash lye, is carried on in lead pans, and with great care.

From the superabundance of the materials for the manufacture of this salt, both west and east of the Cumberland mountains, it is surprising that it has not received the attention of enterprising capitalists, and the same may be said respecting saltpetre, and epsom salts, and copperas, all of which exist in such abundance, and contiguous to each other. In many places in Sevier county there are large heaps of these materials, already having undergone decomposition and awaiting the manufacturer's skill. The cave of Sevier has already been alluded to. This aluminous slate, so valuable in the manufacture of alums, has been regarded by many as coal, and been worked for that purpose. When spontaneous decomposition has taken place in these slates, the result of all the changes is a sulphate of alumina and iron.

WAVELLITE

is a Phosphate of alumina. Found encrusting the limestone of Middle and of East Tennessee. It has been found in Roane.

SILICA

is another very abundant mineral, and is known by the names of sand, flint, quartz, rock crystal. It embraces also all of the finest gems, as amethyst, prase, chalcedony chrysoprase, carnelian, sard, agate, mocha stone; onyx, cat-eye, jasper, bloodstone or heliotrope, lydian stone, opal, cachelong, tabesheer, and many others of inferior quality. The base of all these is silica, the difference being due to different coloring substances, and a different proportion of water.

Sand is an ingredient in most soils, the per cent. of which may be obtained by repeated washings. It is important, as from it many of our productions derive the material to harden their stems, and perfect their growth. It is essential to the perfection of all the cereals and the grapes. Sand in the soil comes from the disintegration of the sandstone rocks, distributed by nature so uniformly among the limestone rocks. While, as a general rule, the limestones are found in our valleys, the sandstones are found on the sides and summits of our hills and mountains. The disintegration of the two, with an admixture of animal and vegetable matter constitutes the generality of our tillable soils.

Sandstones differ in degrees of fineness, and hence are adapted to different purposes. The fine grained are used for grindstones and whetstones, while the coarse grit or conglomerate are worked up into millstones. The best materials for these is found in a silicious stratum, situated contiguous to the sandstones, and above the limestones of

East Tennessee. Along our streams may be found immense banks of fine drifted sand, well calculated for the manufacture of all kinds of glass.

There are immensé masses of sandstone in the slate belonging principally to the coal measures, and the Devorian series. In Monroe county are to be found, in the fields, quantities of perfect crystals of quartz of various sizes and different colors. I have a specimen of amethystine quartz of a lively color, found not far from the Smoky mountains.

It is singular what variety of crystalline substances sometimes enter into one mass. A specimen before me presents sulph. strontian, an impure limestone, quartz crystals, and sulph. lime, all resting the one upon the other. It seems that the impure limestone was the original bed, and on one side the sulph. strontian crystallized, while on the other first the quartz and then the sulph. lime.

TALC.

There are several varieties of soapstone, all of which possess, according to their degree of purity, the peculiar characteristics of a pearly lustre and unctous or greasy feel. Color from white to dark olive green, easily separated into lamina, which are flexible but inelastic, soft. The steatite or soapstone, pearly white, from Nantlee town, N. C., lies contiguous to the stratum of marble noticed as having been opened at Murphy.

It is said that there is a stratum of soapstone on the declivity of Smoky mountains, in Monroe county, of a pearly white color.

There are many purposes to which this mineral may be applied. It is easily cut into vases. For fire-stones it is valuable in furnaces and fire-places. As a polishing pow-

der for other minerals, for extracting grease from cloth, and as french marking chalk, it is indispensable in the arts and trades.

CHAP. III.

EAST TENNESSEE, (CONTINUED.) GLASS—HYDRAULIC LIMESTONE—CLAY, OR ALUMINA
—MILLSTONE GRIT—ROOFING SLATE—CHLORITE SLATE.

GLASS.

But one establishment, we believe, has ever been erected in Tennessee for the manufacture of glass. Two companies have at different times had control of it, but the business is now suspended. The glass manufactured was of the first quality—and there is no doubt but that the difficulty of getting it to market was the cause of the suspension. The crown glass manufactured in this establishment was used for glazing the windows of the State Capitol. It is of superior quality.

Our water courses abound in sand of a pure quality, and our forests teem with wood for the constant glow of the furnace. And in the confident expectation that at no distant day attention will again be turned to these manufacturing operations, we venture to introduce the subject here, as East Tennessee possesses more advantages than she did then for their successful prosecution.

By means of railroads, connection is made with Georgia and the South, and with Virginia. Other roads in contemplation will, when completed, increase the facilities of an outlet, and extend the limits of the market. The majority of the water courses in East Tennessee come from the mountains, and hence bring down pure sand, which is deposited in the bends of the rivers, and upon the islands. This sand of course varies in quality, both as regards fineness, sharpness and color, according to the rocks which have been disintegrated.

The manufacture of glass depends upon effecting a combination between sand and potash or soda. Either of these bases may be used, according as they differ in cheapness. Potash would be the base with us, as it could be readily obtained by lixiviating the ashes of wood. When these two substances are fused together, they constitute a silicate of potash. The best glass which is said to be made, is the Bohemian, and is a mixture of sand, potash and lime. The rounded pebbles which we find so abundantly scattered over our fields and hills—and along our water courses, is similar to that which is used for the manufacture of this glass. The pebbles are heated to an intense degree and then being thrown into water, they crumble to pieces. The fragments are then pounded or rolled so as to obtain a fine powder. The potash and the lime used are both of the finest quality, and the whole being mixed together in regular and well established proportions, are subjected to a flame obtained by the burning of resinous wood. The proportions are: 110 parts of pulverized flint or quartz; 64 of refined potassa, and 24 of caastic lime. During our explorations we have examined many fine banks of white sand along the courses of the Holston and Powell's rivers—and we hope at no distant day to hear of such enterprizes being again commenced. A fine market is afforded all south of us for glassware of every variety, for, on account of its breakage in transportation from the distant eastern cities, it becomes quite expensive before it reaches our markets. An establishment at this point would undoubtedly command the trade of every Southern State.

HYDRAULIC LIMESTONE.

We barely alluded, on page 28, to the fact of the ex-

istence of an argillaceous limestone, which has been supposed to possess the property of hardening under water, when burned into lime.

The stratum, which has been examined, is found at the northern limits of the corporation of Knoxville—and may be traced from one end of our valley to the other. There are two strata lying contiguous to each other. The one is of a reddish color, and is easily split into flags, though frequently reddish white veins of magnesian carbonate of lime are found penetrating to some extent into the contiguous stratum. The other stratum is of a greyish yellow color and more disposed to crumble than the red. Both of these strata have been tested and the preference is given to the red argillaceous limestone. An analysis of the two varieties has yielded me the following results:

No. 1 was a specimen of the reddish variety from the surface of the stratum. It contains too much clay and silix.

An analysis yielded me the following results:

Carbonate of Lime	58
“ Magnesia	3
Oxide of Iron	5
Clay and Silix	39
	100

No. 2 was another specimen from a more solid portion of the quarry, and contained

Carbonate of Lime	62
“ Magnesia	5
Oxide of Iron	4
Clay and Silix	29
	100

I obtained two specimens of limestone from the quarry of Mr. Moffett, below the city of Knoxville, and analyzed them. One was a compact, reddish limestone, with yellowish grey spots, and yielded

Carbonate of Lime and Magnesia	78
Oxide of Iron	3
Clay and Silica	24
	100

The other specimen—uniformly reddish—yielded.

Carbonate of Lime and Magnesia	86
Oxide of Iron	6
Clay and Silica	8
	100

We believe the limestones of that quarry, if properly calcined, will produce a tolerably good cement—and we hope that experiments will be made with it.

In all limestone there is a greater or less degree of impurities. *Fat lime* is that which is obtained from pure carbonate of lime, and is known by its swelling when it becomes moist, and at the same time cooling with a great degree of heat.

When the foreign admixtures of limestone consist of clay or sand, then a lime is yielded which possesses the property of hardening under water. These foreign admixtures must exist in certain proportions, as in fact the value of the cement depends upon the per centage of the different ingredients. It is generally known that the common building mortar is made of one-third lime and two-thirds sand; and according as these two substances are united together, so will be the value of the mortar used. The sand and lime should be mixed together at a time when the lime is as yet caustic—as it is then in a condition to form the silicate of lime. The natural combination of these ingredients existing in the argillaceous limestones affords a quick-lime which, under water, will form an impermeable cement. If there are only 12 per cent. of clay in the limestone, it will form a cement which will require several days to harden. If 25 per cent., then we have a lime which will harden quite rapidly. This is known as the *Roman cement*.

Now, by comparing the character of our limestones with others from which good cement has been obtained, we readily see their value.

Mode of Burning.—In ordinary lime-kilns the object is to drive off the carbonic acid of the carbonate of lime, and great heat is maintained for several days for this purpose.

But in burning *hydraulic limestones*, a great heat must be guarded against. It is true, the principal object of calcining is here also to expel the carbonic acid, so as to bring about a union of the caustic lime with the clay and sand, but if too great heat be employed, the clay, in which silica and alumina exist in intimate connection, fuses together, forming a silicate of alumina, and it will be rendered hard and compact as a brick, and hence the silica being fixed with alumina, no union takes place with the lime.

A gentle and steady heat, therefore, should be employed to a degree sufficient to expel the carbonic acid of the lime as well as the water of the clay.

In the construction, therefore, of a kiln for burning this argillaceous limestone, regard should be had to the draft of air—that it be not too strong, nor variable. While the ordinary kilns are made of an oval form, so as to admit of a strong current through the fires, the kiln for the hydraulic lime should be of equal dimensions, and so constructed in its fire grates that only a limited quantity of fuel could be applied. Remembering that the principal object is to calcine the stone *with as low a degree of heat as possible*.

Uses to which applied.—From the nature of this lime, it is an invaluable cement for walls subject to dampness. Where much use is made of brick for foundations in buildings, a coating of this cement on the inner wall, will render it dry and impervious.

It may also be used for the manufacture of pipes for the conveyance of water. Its principal use is in plastering cisterns. The rapidly increasing demand for good cisterns will render this an important branch of industry in East Tennessee.

In the early history of our country, the cool and grateful spring was the center of attraction, and the nearer the family mansion was erected to it the better. But as cities have sprung into existence, and as the country has been opened, spring-water fails to supply the demand. To the refreshing shower, distilled from heaven's alembic, we are turning for the cooling draught. This too affords a drinking-water more conducive to health. The prevalence of cholera, almost entirely in limestone regions, shows some connection between the geological character of the district and this disease. And as the water we drink, on account of its limestone character, is regarded as the offending agent, attention is being directed to cisterns and cistern water.

CLAY, OR ALUMINA.

The character of the various geological formations of East Tennessee, extending through at least four great geological periods in the world's history, would lead us to expect a variety in its deposits of alumina. These materially differ according as they result from the disintegration of primitive rocks, or slates or shale. The purest is that which proceeds from the decomposed felspathic rocks, porphyries and granites, and is denominated *kaolin*, and so extensively used for the manufacture of *porcelain*. The other clays are used for coarser ware, for pottery and for brick.

The ridges of the Unaka mountains will doubtless afford quantities of decomposed and decomposing felspath-

ic and porphyritic rock—together with granites and gneiss.

The granitic rocks are composed of silex, potassa, alumina and water. These ingredients in fact, in different proportions, compose nearly all the clays. They may indeed be regarded chemically as a silicate of alumina. But while this earth exists so abundantly in this impure form, it also constitutes some of choicest and rarest gems—thus blue alumina is called *sapphire*—red alumina *ruby*, and when transparent and colorless, the *hyaline corundum*. *Emery* also in its different degrees of fineness is an *opaque corundum*.

We have already described the localities of alum and its mode of manufacture. Our desire at present is to direct attention to the quality of our clays, both those resulting from the disintegration of our felspathic rocks, as well as those from our aluminous shales—as highly advantageous for the manufacture of both the coarse and the fine kinds of pottery, earthenware and stone-ware.

But recently, as one of the trophies of the chemical art, a metal, aluminum, has been extracted from clay which for the many purposes to which it can be applied, bids fair, as soon as some cheaper mode is discovered for its preparation, to replace many of the other metals in many of the arts of life. This metal is of a silver white, light, and applicable to many purposes. It may be obtained thus: The chlorides of potassium and sodium are placed with the clay in a crucible and then subjected to a high degree of heat, when the grosser particles of alumina are set free, and there remains a saline mass, in which the small globules of metal are found perfectly pure. The solvent for this new metal is muriatic acid; its melting point is the same as that of silver, but its specific gravity is much less.

Thus it may be seen that the clay of our hills contains within itself a treasure, independent of its use in many of the arts of life—a metal which from its mode of extraction at present is more valuable or costly than silver or gold; yet destined at some day to be so cheap and common that every one may be in possession of it.

MILLSTONE GRIT.

During a reconnoissance made in 1849 of the country between Knoxville and the Cumberland Gap, we passed over, not far from Tazewell, a stratum of silicious stone which would be admirably adapted for buhrstones and millstones. It presented a cellular texture, was quite hard, and filled with small quartz crystals. Occurring on the mountain lands, it may doubtless be found extending along these ranges conforming to the general geological construction of the country.

The same silicious stratum, indicated on our map, may be found all along the most prominent mountain heights—having seen it on Clinch mountain and Copper ridge. As the future of East Tennessee points to her resources as a grain-growing and a manufacturing district—here is afforded ample materials for the construction of stones to grind her cereals into flour. To this we will advert in another chapter.

ROOFING SLATE.

All along the western declivity of the Unaka mountains, from Georgia to Virginia, may be found strata of greater or less thickness of roofing slate. Dipping at various angles into the heart of the mountains, it serves to form the natural roof of hundreds of *rock houses* to be found in this region, whilst the interior of the houses is fur-

nished abundantly with the materials for the manufacture of the salts of commerce. Dr. Troost, in his sixth report, devotes several pages to a description of this slate, from which I will extract, especially his remarks as regards its existence in Sevier county. And the same are applicable to all the others:

“One of the most interesting products of Sevier county is the Roofing Slate, of which it contains extensive ranges. A stratum of it may be seen on the map of that county, lying between French Broad river and the fork of little Pigeon, a few miles north of Sevierville, and crossing the little Pigeon near this town. How far it extends I have not been able to ascertain—but a more extensive stratum is situated towards the south or rather the south-east of Sevierville, running from south-west to north-east, nearly parallel to the great Smoky mountain, and being perhaps a continuation of the Chilhowee mountain in Blount county. As I have observed above, this is a very extensive tract of slate, and from the superficial examination to which I could subject it, no quarries having yet been made in it, seems to be of an excellent quality. I have seen slabs of it, which had been detached by some natural cause, from ten to twelve feet square, and of uniform thickness—perfectly level and sonorous. To the enterprising citizens who shall penetrate this bed, it will yield some other variety of this useful substance.

“In order to give an idea of the usefulness of this slate and to point out its real characters, I beg leave to state that we distinguish the different kinds of slate, only by their exterior character, namely, their smoothness or minuteness of grain, weight, durability, color, extent of slabs, etc. But the naturalist, who looks at the nature of the rock, considers more particularly its geological position, as forming the lowest of the fossiliferous, or sometimes perhaps the uppermost of the non-fossiliferous strata, and distinguishes it, therefore, from another kind of slate which belongs to a more recent formation. But to the Architect these considerations are unimportant.

“The good roofing slate has a dark gray, approaching to a bluish color—showing when polished an infinite number of small brilliant points, lying in the direction of the slaty structure. Such slate is sonorous, is not acted upon by acids, and gives a whitish gray mark, when scratched with iron or a piece of the same slate.

“Slate is not susceptible of a high polish like marble, but it may be brought to a very smooth surface by pumice stone or similar materials, and in this it is unctuous to the touch. Moreover, all slates or similar rocks of whatever color, may be made fit for roofing, if they can be divided into thin laminæ or slabs, which are level and sonorous, and susceptible of being trimmed and pierced with the proper hammer, without breaking, and if they absorb no water, when they have been for some

time submerged in this fluid. Because, if this were the case, the frost would soon destroy them, whatever might be their other good qualities.

"The strata of slate in Sevier county are very much inclined, approaching almost to a vertical position. It is this inclination, together with the thickness of the strata, that determines the mode of extracting the slate; we can therefore prescribe no general rule for working these quarries; some require subterraneous galleries, others perpendicular shafts—while others again may be worked above ground, as in common stone quarries. These are therefore circumstances which are entirely local.

"The leaves of which the strata of slate are composed, are sometimes parallel to these strata, but oftener perpendicular to them.

* * * * *

"It is necessary that the slate should be split up in laminæ in the quarry, as soon as it is separated from the stratum, because whenever it has lost the natural humidity, which pervades the rocks in their natural position, it becomes difficult to split.

"It is not necessary to enumerate all the purposes for which slate may be used. A roof made of slate lasts fifty years without repairs, and when repaired will last fifty years longer. It is impermeable to rain and entirely fire-proof. It will not melt like zinc, when exposed to heat, nor rust as do tin roofs, wherever the tin, by some accident, is removed from the iron, nor burn as do our common shingle roofs. When a fire takes place in a house, it is often the case that the fire is communicated by the roof to the next—it is seldom the case therefore, in our towns and cities, that one house alone is destroyed by fire, but generally several at a time. In Europe where the houses are covered with tiles or slate, these extensive conflagrations seldom take place.

"The slate may be used for stoves and fire-places, for cisterns, evaporating pans which are heated by steam, and the coarse kinds make the best flag-stones—and when polished, slate forms fine tables and tablets for writing."

CHLORITE SLATE.

is found accompanying quartz, from Coqua creek, Monroe county, and is an indication of gold. It is in this quartz vein, with its accompanying chlorite slate, that the gold of the Whippo-wil mines, on Coqua creek, is found.

The slate is of a dark olive green color, somewhat granular, easily splitting into slabs. On Coqua creek it forms large masses. This chlorite slate may be traced in a N. E. direction along the western declivity of Smoky mount-

ains to the point where it crosses into N. C. To S. W. it may be traced to the Ocoee river, and is seen projecting from the bluff on the Ocoee turnpike at a point about 15 miles below Congdon's. This illustrates the bearing of the rock formations through these mountains. While it inclines at the usual dip of 45° to the S. E., its course is to the E. N. E., hence a line drawn from this point, with that bearing, will be found to pass over the same slaty chlorite on Coqua creek, and will cross Smoky mountains about the point where the Tennessee river has cut its way.

Chlorite slate often contains imbedded crystals of sulphuret of iron. These crystals are often several inches in diameter, and, when they fall out, leave a square, deep indentation in the slate.

Chlorite slate belongs to the metamorphic or primordial rocks, among which are also to be found many different varieties of hornblend, containing fine crystals of garnet; also mica slate, felspar, porphyry, amethystine quartz, many of which need only the skill of the lapidary to turn them to good account.

CHAP. IV.

ORES OF EAST TENNESSEE. IRON—LEAD—ZINC—COPPER—GOLD—SILVER.

Although we are not of the number who believe that the wealth of a country consists in its mineral resources, to the exclusion of its agricultural facilities, yet when the two are combined, as in East Tennessee, the elements of prosperity are thereby greatly advanced.

In this portion of the State, nearly the entire mineral wealth, with the exception of the iron developments in the Cumberland mountains and in Middle Tennessee, exists, and that too in such quantities as to admit of a greatly increased amount of capital for its development. This

of itself, now that it is being intersected by lines of railway, will bring into this healthful region ere long an industrious population, the reflex influence of which will be felt, not only in the increased amount of her agricultural products and their enhanced value, but also in all the arts and trades of life.

While, therefore, the future history of East Tennessee may now be said to be engraven with every stroke of the miner's pick, it will doubtless be so indelibly traced as not to be effaced for ages to come. Each new development will add to a knowledge of this rich store-house, and each shaft sunk be but as ladders, the deeper they extend, wherewith to explore its valuable recesses.

IRON.

In order to present the iron interest in a connected manner, we will deviate from our plan, and offer the result of our explorations throughout the State, as well as such facts as we have been able to gather, into one section.

There are six varieties of iron ore to be found in Tennessee—nearly all of which are profitably worked.

1. Cranberry iron ore—magnetic ore.
2. Brown hematite or hydrous peroxide of iron.
3. Red hematite or argillaceous iron ore.
4. Sulphuret of iron.
5. Carbonate of iron...
6. Native iron, or meteoric iron.

From Carter, all along the Western declivity of the Unaka mountains, through the valley of East Tennessee, interstratified with the coal measures of the Cumberland mountains, and throughout the silicious region which surrounds, with its bold, irregular escarpments, the rich agricultural region of Middle Tennessee, and extending be-

yond the Tennessee river along the eastern counties of the Western Division, these ores, the one or another, are found in all abundance and of unquestionable quality.

GEOGRAPHICAL DISTRIBUTION.—1. *The Cranberry Iron ore*, which is *Magnetic*, is to be found in the counties of Carter and Cocke, and in all probability in the intermediate counties. It is associated with a greenish mineral *sahlite*, and occurs among the mica slates. It doubtless occurs in all of those counties along this mountain range where these slates and other primordial rocks are to be found in our State.

Dr. Troost, in his fourth report, thus speaks of this ore :

"The iron ore of the primordial formation is generally that kind which is called *magnetic iron ore*. Immense quantities of this ore are found in the north-eastern parts of the United States. And not to speak of the vast deposits of this ore in similar formations in Washington county, Missouri, which have formed these fifty years one of the wonders of the west, nor those of Elba, which produced most of the iron used by the Romans, and the mines of which are yet considered as inexhaustible ; I must mention one situated near the limit which separates the State of Tennessee from North Carolina, at the foot of the Roan mountain, in Carter county. It seems to be an extensive vein of rich magnetic iron ore, similar to that of some parts of Sweden, and is accompanied with the same minerals as the Swedish ore, namely, a variety of pyroxene (*salite* or *malacolite*)."

But while this ore is associated with the *sahlite* in Carter, it is not to be found with it in Cocke county.

This ore is found compact and in layers, possessing an uneven fracture, color iron black, with a metallic lustre. Its streak and powder are *black*, and contains, according to Philips,

Oxygen	28.22
Iron	71.78
	100.00

This ore is characterized by its *polarity*, hence called *native lodestone*. Like the magnet, it loses its magnetic influence by rough usage or by heat.

It is an ore of the earlier rocks—and occurs among them in beds and masses. This ore is the same as that from which the noted Swedish iron is manufactured, and the products of the banks in Carter command a higher price in the market than that of any other ore. These ores are principally the property of Mr. Hampton and John Harding, Esq., some eight or ten miles east of Elizabethton.

The banks of ore are almost inaccessible, being among the mountain ranges, near the State line, but a good macadamized road or a branch railroad would render available one of the most valuable iron ores in the State.

2. *Brown Hematite or Hydrous Peroxide of Iron.*—This variety of ore is that which occurs so abundantly throughout Middle Tennessee, in some portions of the Cumberland mountains, and also in East Tennessee. Were we to designate the counties in which this ore is found, we might enumerate all belonging to the Western Division bordering on the Tennessee river. In fact, it enters largely into the iron interest of Tennessee, and wherever found differs but slightly. There are local names given to it by the iron men, but as a general rule it belongs to that class into which water, iron and oxygen enter as ingredients. The component parts are put down in works on mineralogy as follows:

Iron	50
Oxygen	25
Water	25
	100

and the yield of metal is 50 pounds to the hundred of ore.

This ore occurs massive or stalactitical or botryoidal, sometimes in pots, which when opened present a beautiful iridescent surface. This is designated as *brown hematite*. It is called an *ochre* when of an earthy stratum and yel-

low, *clay iron stone* when hard and impure, and the *bog ore* when found in low localities.

The powder or streak of this ore is *yellow*.

The silicious region throughout Middle Tennessee and the silicious hills and knobs of East Tennessee seem to be uniformly the deposit of this ore of iron—which was in all probability formed subsequent to that of its silicious bed. This silicious bed or stratum, as we will hereafter show, rests upon the limestone strata of East and Middle Tennessee, and lies beneath the cretaceous formation of the Western District. Wherever the channels of the water-courses are cut through this silicious stratum the out-cropping of the iron, with its accompanying slates and chert rocks, may be found on opposite sides of the valley.

In 1832, Dr. Troost found only six blast furnaces in Middle Tennessee, to which were attached ten refining forges, containing twenty-three hammers and fifty-one fires, to make blooms. But in 1836 the number of furnaces had increased to twenty-seven, producing on an average 27,000 tons of iron annually. No information is given by him at that time as to the manufacture in East Tennessee.

In his fifth report, 1840, he gives a full description of the iron ores of Cocke county—which he found traversing the slate rocks in several directions. The ores of Long creek, the property of Mr. Birdseye, and which supplied Legion furnace—the ores of Grass Fork creek—the ores of Stone's creek, on the lands of Mr. Holland—those of the Dry Fork of Wolf creek; and those along the banks of Big Pigeon river, were all examined and pronounced by him to be abundant and of excellent quality. These streams also, as well as many others found in this country, are well adapted for furnaces, forges and

bloomeries. This may also be said with reference to all those other counties along this range of mountains, from the Carter banks to Tellico river.

A bank of no mean importance of this hydrous oxide of iron has been opened in the eastern limit of Knox county, and we have examined another some two miles south of Loudon. But as yet, neither through the interior of the valley of East Tennessee—nor through the limestone valley of Middle Tennessee, have we discovered any considerable workable quantity of iron ore. It seems principally confined to the silicious ridges.

The localities of the hydrous peroxide of iron may be stated to be embraced in the counties of Sullivan, Carter, Johnson, Washington, Greene, Cocke, Sevier, Blount, Monroe, Polk and McMinn in East Tennessee, and Warren, White, Coffee, Franklin, Lawrence, Wayne, Hardin, Lewis, Hickman, Perry, Decatur, Dickson, Humphreys, Montgomery, Benton and Stewart in Middle and West Tennessee. It will thus be seen that in the eastern division of this iron field, the ore runs along the declivity of the Unaka range of mountains; while in Middle Tennessee it runs upon that elevated table land which surrounds the fertile agricultural counties—and which was designated by Dr. Troost as the silicious region. The two formations of these two divisions differ in geological position.

3. *The red Hematite or Argillaceous Peroxide of Iron.*—This is the third variety of iron ore for our consideration. It is that variety which occurs as a band all along the eastern declivity of the Cumberland mountains, from the Cumberland Gap to the Raccoon mountains on the Georgia line. It is found of various thicknesses, from one to ten feet, and from the fact of its occurring on the sides of the

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This ore occurs of different degrees of density, from a hard solid mass, to a soft unctuous lump.

Its streak or powder is *red*. It is known by various names, as *specular iron*, *red chalk*, *dyestone*, *scaly oxide of iron*. The composition of the ore is, according to Phillips,

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One hundred pounds therefore yielding seventy of metallic iron.

The counties in which this ore is to be found, are Claiborne, Campbell, Anderson, Roane, Rhea, Hamilton, Bledsoe and Marion along the Cumberland range, and in Carter, Johnson, Sullivan, Greene, Cocke, Sevier and Monroe along the Unaka range. One locality is deserving of special notice which, though as yet unexplored, presents such a bold and massive appearance, that it is destined at no distant day, to be the seat of extensive iron establishments; I allude to Elk river Gap, in Campbell county. The route of the Knoxville and Kentucky Railroad has been located through this Gap. Although all along the Gap there are out-crops of strata of this sealy oxide of iron, yet at one point especially it presents a perpendicular cliff of more than 30 feet, a solid stratum of iron ore, disappearing under the mountain. It may be called the *Iron mountain* of Tennessee. Con-

tiguous to it, all along the mountain heights, may be found coal of a superior quality, while the full, rapid stream of Elk river is sufficient to drive forges of any power.

The different varieties of this ore are distinguished by a greater or less degree of purity and hardness, and hence it has received from the miners peculiar names: such as specular iron, red hematite, red chalk or ochre, clay iron stone. That which occurs in the Cumberland mountains is stratified and of different degrees of hardness, some constituting the lenticular argillaceous ore, consisting of small grains agglutinated together.

Some of the strata are also fossiliferous, its surface presenting several species of corals, crinoideal stems and shells.

This ore is profitably worked in all its localities—and is that of which the iron banks of England are usually composed, being found there, as here, associated with her coal measures.

In East Tennessee there are seven furnaces driven with water-power blast, and two with steam-power. There are also eighteen forges and thirty-two fires, in all of which this red hematite is used.

4. *The fourth variety* of Iron ore found in Tennessee is the Sulphuret, generally known as Iron Pyrites, and frequently, especially when in coal, receiving the name of sulphur. This ore is found associated with all of our rocks—being found from the Metamorphic slates to the latest limestone. It is associated with the Copper ores in quartz, with the chlorite slate in cubes of various sizes—with the alum and magnesia slates—with the limestones and with sandstones.

Specimens have been collected from the copper region at Ducktown, where it constitutes the *Mundic* of the

miners—from the chlorite slate at Coqua Creek in Cubes, where it lies contiguous to the Gold—from the slates of Sevier and Monroe, where by its decomposition it favors the production of alum, and of sulphate of Magnesia—as well as of Copperas—from the limestone of East and Middle Tennessee, where it occurs in detached crystals or masses.

The use of this ore of iron is in the manufacture of Copperas and of Sulphur. The Copperas or sulph. iron is, in fact, the result of the decomposition of the ore by exposure to air and moisture, and is the process which is continually going on in the ore as it occurs—as in cabinet specimens. All that is necessary to produce the copperas of commerce is washing and crystallizing. The Sulphur is obtained by heating the ore to redness, by which it is driven off in fumes into a separate chamber or vessel, where it is condensed.

The abundance of this ore of iron in the hills of East Tennessee holds out inducements to capitalists for a profitable investment in the establishment of manufactories.

5. *Carbonate of Iron* is found quite abundantly in the counties of Morgan and Campbell. It occurs in rounded nodules or pebbles of various sizes, made up of concentric layers. It is a rich ore, easily worked, and its ready accessibility, on the completion of our Kentucky Railroad, will render this a valuable variety. It is also known by the name of *Clay iron stone* and *sparry iron*. The value of this ore generally arises from its association with the coal measures. It is highly probable that it is quite abundant, and, if found to be so, will add the more to the metallic wealth of our State.

An analysis of one of these iron stones yielded 39 per cent. of metallic iron. My attention was first directed to these nodules by Prof. Mitchell.

6. The sixth variety of iron ore in our State is in detached specimens. It is the *native iron*. This variety, which is pure iron and not an ore, is supposed to be of meteoric origin, but how formed and whence it comes is of course altogether hypothetical. Its characters, as well as its localities—having been in every respect isolated, in roundish masses—indicate its origin. Two specimens are in my possession, the one found in Grainger and the other in White county. The Grainger specimen weighs $4\frac{1}{2}$ ounces, said to have been from a mass of 20 lbs., and the White specimen, half an ounce—size of mass not known. Both specimens present a crystalline structure on the freshly broken surface, of a dark iron color, and readily malleable.

In Dr. Troost's Fifth Report, 1840, there is described the meteoric metallic mass found in Cocke county.

He thus speaks of it :

“The original weight of it is said to have been about two thousand pounds. The parts that I have seen, and that which is in my possession, are a singular heterogeneous mixture, composed of metallic iron, carburet of iron, or graphite, sulphuret of iron, hydroxide of iron, brown and yellow, the brown being very hard, the yellow very soft (like gypsum ;) in some pieces all these ingredients form a kind of heterogeneous mixture.

★ The most interesting part nevertheless, and which occupies about ninety-five hundredths of the whole mass is the *nickeliferous iron*. It is partly of a crystalline structure and partly composed of irregular grains of various sizes and forms, sometimes merely agglutinated, sometimes separated by a thin flexible pellicle of a highly polished metal, viz : highly carbonised iron. The crystalline part is composed of laminæ, which vary in thickness forming sometimes equilateral triangles, which are separated, the one from the other, by very thin laminæ or pellicles of a brilliant steel polish as mentioned above, and being remarkably flexible, I expected to find these triangular laminæ placed in such position as to form octahedrons, or showing a cleavage parallel to the sides of that solid ; but this is not the case, the cleavage gives a regular tetrahedron. I have one of these forms which measures about one inch from the base to the apex. This metallic iron is besides dispersed in irregularly shaped little masses through a solid compact brown hydrated oxide of iron, through which it is also dispersed in invisible grains, which can only be detected by the magnet which attracts them when the substance has been reduced to powder.

This iron is malleable ;—I have in my possession a horse-shoe nail which was made of it without having undergone a previous preparation, and it is harder and whiter than common wrought iron. Its hardness is perhaps owing to a small quantity of carbon, or perhaps to nickel—but the color of the iron in its natural state, before it has been subjected to any operation, differs much in different parts. In some it is black and has no metallic lustre at all ; in others it has a brilliant lustre, and is then always much whiter than steel or common iron.—This iron is but little susceptible of being tarnished when exposed to the action of the atmosphere—the black part may be rendered white by a file. It is covered also here and there with a kind of black varnish.”

Prof. Safford, at present Geologist of the State, describes a meteoric mass which fell in Lincoln county.

He says :

“This specimen, which now lies before us, has an edge broken off, revealing the character of the interior. Within it is of an ashen-gray color, varied by patches of white, yellowish, and dark minerals. (§ 283.)

With the exception of the broken edge, it is covered, and when first obtained was entirely covered; as most meteorites of this kind are, with a very thin “black, shining crust, as if it had been coated with pitch ;” this was doubtless formed by the fusion of its outer surface in its rapid passage through the air.

One end or face, which may be regarded as the base, has an irregular rhomboidal outline, averaging $2\frac{1}{2}$ by $2\frac{1}{2}$ inches. Placing the stone upon this end, the body of it presents the form of an irregular, slightly oblique, rhomboidal prism. The upper end, however, is not well defined, but runs up to one side in a flattened protuberance, giving the entire specimen a form approaching roughly an oblique pyramid. The length from the base to the apex is $4\frac{1}{2}$ inches.

Three adjacent sides are rough, being covered with cavities and pits. It is likely that the stone has been torn off from a larger mass, or from other fragments, along these faces.

The other sides are smoother and rounded, and appear to have constituted a portion of the surface of the larger mass.

The specimen acts upon the needle ; fragments of it readily yield particles of nickeliferous iron by trituration in a mortar. The specific gravity of the entire specimen is 3.20. Its weight, in its present condition, 3.83 lbs.”

To the same Report of Prof. Safford we are indebted for the following

TABLE OF TENNESSEE METEORITES.*

No.	County in which found.	General character.	Weight.	Year of finding.	By whom and when described.	Person with whom name known.
1	Sumner.	Stony.	11 lbs.	May 8, '75.	Sherbert.	
2	Cocke.	Malleable iron.	2000 "	Unknown.	Travis, 1881.	Dr. John P. A. Anderson, Ark.
3	Dickson.	"	9 "	July 1881.	"	"
4	Greene.	"	20 "	Unknown.	"	Mr. J. W. Anderson and Dr. J. P. A. Anderson, Ark.
5	DeKalb.	"	36 "	"	"	"
6	Jackson.	"	15 lbs.	"	"	Col. A. J. Morgan.
7	Smith.	"	246 lbs.	"	"	"
8	Rutherford.	"	19 "	"	"	"
9	Jefferson.	"	27 lbs.	"	Shopton, 1881.	Dr. J. P. A. Anderson.
10	Claiborne.	"	60 lbs.	"	Shopton, 1881.	Dr. J. P. A. Anderson.
11	Campbell.	"	45 lbs.	"	Shopton, 1881.	"
12	Lincoln.	Stony.	3 lbs.	Aug. 1, '76.	Shopton, 1881.	Dr. J. P. A. Anderson.
13	White.	Malleable iron.	Unknown.	Unknown.	Shopton, 1881.	Dr. J. P. A. Anderson.
14	Grainger.	"	20 lbs.	"	"	Dr. J. P. A. Anderson.

* Since the foregoing table was arranged for this work, another specimen of native iron has been presented to me by Prof. R. L. Kirkpatrick—and which is situated in the eastern part of Anderson county. The weight of the specimen is about eight pounds, and of a columnar line structure; steel grey lustre, and soft or malleable. It has a thin coat of oxide of iron encrusting the surface, except at one end, which appears to have been broken, and cut, as the surface is jagged, (not smooth.)

PRODUCTION OF IRON, AND ITS CONSUMPTION.—We have said enough to prove the inexhaustible character of our Iron banks. We have shown that four at least of the varieties are of excellent quality, and are already profitably worked. Nature has placed together in such abundance two of the elements of national greatness, that our State will be blind to her own interests if she does not promote every facility for their development. This she can do by putting into operation extensive systems of railways, stretching over the surface of her territory like network, and serving as the means for opening up and bringing to market the vast treasures of mineral wealth which lie entombed in the bosom of her hills and mountains. To this England owes much of her present greatness, and not until her iron banks and coal beds are

exhausted will the shrill whistle of the Locomotive cease to be heard in her borders. She has felt the importance of those treasures which lie beneath the feet of her overcrowded population, and she promotes every means in her power to develop those resources, so that it may be safely said one-fifth of her population live beneath the surface of her soil.

In contrast with this picture of English operations, what do we see presented in our own country? What in our own Tennessee? We see the singular spectacle of a nation possessing far more of the raw material than England, and yet deriving more largely of the manufactured articles by importation than she manufactures herself, and more than is imported into all other nations on the globe. Her hills are based on iron and her soil is impregnated with it, and yet, when any enterprize of note is undertaken, English or Swedish iron has the preference, if it can be obtained. But although it was contended only a few years ago that we had not the facilities for bringing out the ore and the iron to market, yet now that the Railway system has been so generally adopted, penetrating the inmost recesses of our mountain coves, traversing our fertile valleys, tunneling our Alpine heights, and developing their rich treasures of coal, iron and other minerals, the extent of our own resources will begin to be appreciated, and thousands of busy hands be employed in their production and in their consumption.

From a work on the statistics of coal by R. C. Taylor we are told that while England produced from her mines in 1845, 1,512,000 tons of iron, the United States only produced 502,000 tons.

In 1852, England manufactured 2,901,000 tons, of which she exported to the United States 808,133 tons,

working up the remainder into the various forms of needles, knives, razors, nails, machinery &c., which she distributed throughout the world, the United States taking for her use a large share—fully one-half.

During the same year, the manufacture of iron in the United States amounted to 750,000 tons, or not quite as much as was imported. None of this was exported, showing the amount required at that time for our own consumption, and all of which we should have produced from our own iron banks and coal beds. What is the consequence? Our apathy is arousing English capitalists to avail themselves of our mineral beds—feeling assured that here they can procure iron as good, and profits as great, as by working their own mines. Not a month passes that we are not visited by the agents of some English company, coming to examine for themselves, and for the purpose of investing where they find the chances of success good. We will presently allude to the result of this supineness on the part of our citizens, by which the rich copper district at Ducktown has almost entirely passed into English hands, but few indeed of our citizens holding an interest in them. And yet we say to all, come with your capital for the field is ample, and the resources great.

During the year 1853, according to the Report of the Secretary of the Treasury, the value of iron imported into the United States was \$29,015,364, of which nearly \$16,000,000 was for bar iron alone; and the duty which had to be paid on these imports, for that year was \$8,104,609—whereas during 1850, the value of manufactured iron in the United States amounted only to \$38,000,000, only one fifth more than was imported a year or two afterwards. And in Tennessee, during the year 1854, the

entire value of all the iron manufactured, according to an estimate of the State Geologist, was but little short of *two millions of dollars*. Tennessee thus for the year 1854 bore the ratio to the States of the Union of *one twentieth* in Iron production, and at the same time consumed her share of imported iron for railways, imported machinery, and manufactured products. For her home-made iron she realized less than she expended for the imported products.

New Discovery in the Manufacture of Iron.—In this connection we will insert a brief account of a new process in the manufacture of iron by which much labor is saved, and at less expense.

The earlier manufacturers employed human beings to stir up the molten mass to separate the clay or cinder.—Mr. Nasmith introduced steam for this purpose, by forcing it from below, and causing the mass to boil like a pot. The new discovery employs “air—the food of fire—which permeated the mass, and with carbon of the iron intensified the heat and freed the mass from matter out of place.”

While in the ordinary process six heats are necessary to carry the iron through all of its stages of purification—in the new process only one is required. In the ordinary process the ore first passes into pigs—but in the new, it runs from the furnace into the refining pot, where, by increased heat, the superfluous carbon is burned out.—This affords malleable iron ready for the rolls. And here again a new arrangement is made. Instead of a series of grooves on one cylinder, there are a series of cylinders, with one groove, gradually decreasing in size so that the iron bar introduced at one cylinder passes successively through the entire series without the laborious handling

practiced in the ordinary process. Thus the ingot, delivered from the refining furnace, passes one rail to the first pair of rolls with its original heat, and through them to the next, and so on till the bars were completed without being touched by the hands.

The great object to be secured by this new process is the manufacture of iron of homogeneous structure as well as in the saving of labor and of expense. Flaws frequently occur in masses of Iron, owing to the imbedding of scales of oxidized iron in the malleable mass, and such flaws are detrimental to machinery, and to artillery pieces. It is believed that the new process obviates such results. The English papers are full of accounts of the new process. By one Journal it is said to produce, *without fail, better iron than Swedish and ten dollars per ton cheaper than common British.* The London Times expresses the conviction that the discoverer "HAS PRODUCED THE GRANDEST OPERATION EVER YET DEVISED IN METALLURGY." By it "the Puddling Furnace is entirely dispensed with, and the new process is said *to convert in a day as much malleable iron as fifty puddling furnaces, and with less than one hundredth part of the labor.*"

Thus it will be seen that the sole process of this new method consists in converting the crude iron from the ordinary blast furnace into ingots of malleable iron or steel which is accomplished by *the application of heat rendered inconceivably intense by blasts of cold air.*

Any one, acquainted with metallurgic processes, knows what effect atmospheric air has upon red hot iron. In still atmosphere the rapid formation of scales is evidence of slow combustion, but if a strong blast of air be forced upon it, it is rapidly burned away. It is this fact which is made to act in the new plan—*air* is rapidly made to permeate the heated mass of molten iron.

Mr. BESSEMER is the inventor of this new process.

And yet though he has been for two years making experiments with this new process, in our country the same operation has been pursued for three years by the Magnetic Iron Company, Mott Haven.

ZINC.

The Ninth Geological Report of the late Dr. Troost was devoted almost exclusively to a description of the Zinc ores of Tennessee and the mode of their conversion into metallic Zinc.

The most important localities are to be found in East Tennessee. We will describe each of these in detail.

1. *Claiborne Ores*.—The deposits of Zinc in Claiborne county are found near Powell's river, about 20 miles South-West of Tazewell. Shafts have been sunk in several places, and the ore taken out in considerable quantities. It is associated with galena or sulphuret of lead. When we visited these deposits in 1849 we ascertained that they occurred along a great *anticlinal axis* which extended N. E. and S. W. throughout Powell's valley. In many places the ore cropped out upon the surface of the ground, and in others was reached by means of shafts, which had been opened to a depth of about 60 feet. It was found in fissures of the limestones of various thicknesses. The ore found in these deposits consists of three varieties, viz:

1. Carbonate of Zinc—*Calamine*.
2. Silicate of Zinc—*Electric Calamine*.
3. Sulphuret of Zinc—*Blende*.

The mineralogical characters of these three varieties are the same in all localities.

1. *Carbonate of Zinc* is composed of,

Oxide of Zinc	64
Carbonic acid	36
	100

or about 51 per cent of metallic Zinc.

It is found as incrustations or stalactitical concretions —also in porous masses. It possesses a waxy lustre, of an impure white or bluish gray color; sometimes it is of a granular compact structure and opaque.

It is distinguished from other ores of Zinc by its effervescence with acids.

It is found associated with the magnesian limestone.

2. *Silicate of Zinc*, or Electric calamine, is also found with the foregoing variety.

It is composed, according to Dr. Troost, of,

Silica	25
Oxide of Zinc	67
Water, &c.	8
	100

which gives more than 53 per cent of the metal in the ore.

This ore occurs in stalactitical concretions, also mamillary and encrusting.

Its color is white, but varies from that to brown with shades of blue and green. It does not effervesce like the carbonate, but in hot sulphuric acid it dissolves, and the solution on cooling, gelatinizes. By friction or heat, it becomes electric.

In former years this ore and the carbonate, were the only ores used in Europe for the manufacture of metallic Zinc.

Dr. Troost recommends to those who would distinguish these ores from those minerals which they resemble, to expose a small quantity for 15 or 20 minutes to a low red heat, then to pulverise and sift, and mix the powder with

pulverised charcoal and filings of copper; then to expose this mixture in a small crucible for a sufficient length of time to the heat of a blacksmith's fire, and see whether the copper has increased in weight, and been converted into brass; if not, no Zinc was present in the specimen assayed.

A readier process is to pulverise the specimen and throw it upon ignited charcoal. If Zinc be present it will volatilize as a white cloud, readily condensing on any cold metallic plate held over it.

Encrusting crystals of quartz are frequently supposed to be Zinc. They may not only be detected by the foregoing process, but also by the microscope revealing the minute prismatic form of the quartz crystals.

3. *Sulphuret of Zinc* or Blende is also a common ore, associated with galena, and with the other ores of Zinc. It is composed, according to Dr. Troost, in the ores from Powell's river, of,

Zinc	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	61.00
Iron	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1.50
Lead	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7.50
Sulphur	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	21.00
Earthy matter	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9.00
																				100.00

Thus it will be seen that there are also other admixtures with this ore of Zinc. Indeed there are frequently found with it the sulphuret of lead, iron, arsenic, cadmia and copper.

This ore has a waxy, yellowish color, and affords a white streak—has the appearance of resin, and not much that of an ore. When heated, it emits fumes of Zinc.

These deposits of Zinc in Claiborne county have not been tested to that degree commensurate with their importance. The value of Zinc, as one of the ingredients of

brass, should insure for these localities at least a share of the investment of capitalists, till their true character has been fully developed.

2. *Jefferson ores*.—These same ores of Zinc occur in several localities in Jefferson and other counties. The foregoing description will suffice.

A few miles to the North-east of New Market they are found in irregular veins in the limestone rock, similar to those of Powell's valley.

Throughout New Market valley, surface-specimens of these ores have been found. In some places slight explorations have been made without any discouraging results. Dr. Troost also notices a locality near Dandridge, in a branch running into the French Broad River.

Near Mossy Creek, not far from the East Tennessee and Virginia Railroad, a new deposit has been discovered of carbonate of Zinc, and there is another near the Panther Springs, called the Swingle Mines, both of which localities give fair indications of being valuable.

3. *Knox county ores*.—Following the direction indicated by the veins of Jefferson county, we find that they lead us into Knox county. South of the Holston river, one mile from Knoxville, in the reddish variegated limestone, Dr. M. W. Dickeson found a vein of carbonate of Zinc, which is believed to be important.

On the waters of Roseberry creek, east of Knoxville, there is a fine deposit of carbonate of Zinc, the vein pursuing a N. E. and S. W. course.

In the cut of the Rabun Gap Railroad, within the corporation limits of Knoxville, near the river, a vein of *red Zinc ore* has been opened, associated with the magnesian limestone. Its extent or importance is not known, as it passes under the bluff.

4. *Blount ores*.—Dr. Grant, on the line of the Georgia Railroad, has brought to my notice a fine locality of sulphuret of Zinc, associated with the same magnesian limestone, in Blount county. The specimen presented to me was of fine appearance.

At Loudon, Roane county, there is also said to exist a locality. Following in the same general direction, deposits have been found some eight miles to the South-west on the lands of Mr. Bowman, and on as far as the mouth of Suee Creek, where it empties into the Tennessee. So that taking New Market as a starting point of observation, these irregular veins of Zinc, associated with galena as we will presently show, may be traced either to the South-west along one of the great folds which characterize the geological formations of East Tennessee, or to the North-east into the upper counties. From the representation of friends, we are led to believe that they may be found through Greene, Cocke, and on to Carter county. Specimens of carbonate of Zinc have been shown us from Washington county.

Process of Manufacturing.—Regarding these deposits of Zinc as valuable, we will append a few suggestions as to the different modes of extracting the metal from the ore. The process for extracting the Calamines differs from that for the Blendes.

The furnaces used for the former are known as Watts, Dillgers, the Liege and the Silésian.

The ore is broken into fragments, and the impurities of iron or lead separated as perfectly as practicable. The ore is then calcined, which drives off the carbonic acid and renders it friable. It is then carried to the powdering mills, and mixed with charcoal, and being placed in earthen retorts, is subjected to a strong white heat.

This reduces the oxide of Zinc, expels the carbonic oxide gas, and the metallic Zinc condenses in allonges fitted to the retorts. The melted Zinc is then run into rectangular moulds in pieces weighing from 60 to 70 lbs. (Regnault.) The ingots are again melted in a reverberatory furnace, and run into moulds of a suitable size for rolling. It is then passed through heavy rollers which produces the sheet Zinc.

The blende or sulphuret, has first to be roasted in heaps to drive off the sulphur, and the friable ore is then subjected to the action of flame in a reverberatory furnace by which the oxidation of the Zinc is completed. After which the process is similar to that for the calamines.—(Regnault.)

Uses.—Sheet Zinc is used for many purposes in the arts. It is very durable as a roofing material for houses—but its principal application is in the manufacture of brass, by forming an alloy with copper, and into white Zinc paint. These two ores are of sufficient importance to attract attention to the deposits of Zinc to be found in East Tennessee.

The construction of a smelting furnace at the copper mines of Polk county, would be an additional inducement to test the value of these Zinc ores. And should the expectations concerning them be realized, there will be necessarily instituted a series of manufacturing operations which would prove of immense importance to our State and to the South.

The extensive use which is now made of Zinc paint, its durability, as well as its fine polish, renders even the *probability* of value in our Zinc deposits as deserving of attention. Zinc paint is a white oxide ground up in oil, and it may be readily seen that the process which consists in freeing the ore of its impurities and reducing it to

an oxide instead of a metal, is that by which a dry paint is obtained. On plates of sheet Zinc a whitish coating is frequently found, which is an oxide generated by the action of atmospheric agencies upon the metal. So that in obtaining the oxide, the process may stop short of converting the ore into metallic Zinc, or it may take the metallic Zinc and re-convert it into an oxide.

M. Leclaire, of Paris, the discoverer, sold his patent right to the Vielle Montagne Zinc Mining Company, who alone have the right to manufacture by the Leclaire process in Europe and America.

In this country we have the New Jersey Zinc Company, and the Pennsylvania and Lehigh Zinc Company. They have been in operation for several years. The former company, in 1853, manufactured 1805 tons, from which they netted a profit of \$90,592 16, and paid \$42,944 50 in dividends.

LEAD.

Considering the number of localities in which Lead ore is found in Tennessee, and the readiness with which the metal is extracted, and its uniformly high price, as well as demand, it is surprising that they have not received a greater share of the attention of capitalists.

In nearly every county in the Eastern division of the State, these ores are found in greater or less quantity associated with the ores of Zinc, and in some localities containing traces of silver.

The counties of Carter, Jefferson, Grainger, Anderson, Claiborne, Roane, Blount and Marion in East Tennessee, and of Davidson and White in Middle Tennessee, have yielded fair specimens, the profitableness or value of which depend only on the quantity found.

Dr. Troost in his Reports describes the deposit in Davidson, and speaks highly of its prospects. The same vein may be traced westwardly, exhibiting an outcrop in the bed of Brown's creek, near the residence of Judge Humphreys. Other outcrops are found to the east of Haysboro', where it was originally opened.

In East Tennessee, the deposits are said to be of good quality. Those which I have had the pleasure of examining personally, and also those from which large specimens of galena have been presented to me, afford good indications.

In Carter, about 10 miles east of Elizabethton; in Jefferson, near New Market; in Anderson, on Hind's creek; in Claiborne, on Powell's river; in Roane, from Dr. Grant's deposits; and in Grainger 6 miles to the north of Rutledge, are, so far as I am informed, our best localities. There is said to be a cave in Jefferson county, near Red Sulphur Springs, in which the stalactites are beautifully encrusted with crystals of Zinc and Lead.

The principal ore of Lead in Tennessee, is the *sulphuret*. It differs however, in external appearance. The Grainger and the Roane ores are somewhat crystallized in cubic crystals—while the Carter, Jefferson and Claiborne ores are granular. The former are distinguished by the name of galena, and the latter are most generally argentiferous.

Carbonate of lime, and heavy spar, are the most usual associated rocks.

As yet, only imperfect explorations of these Lead deposits have been made, the most extensive being carried on in Powell's valley. Here the ore has been reached by means of shafts, and found to lie in veins, between the fissures of the slightly inclined limestone strata. These explorations were made as early as 1848, and have been renewed at times, still giving indications of ultimate success to the patient explorer.

The following analyses of Lead ore were made by Dr. Troost, and presented in his Ninth Report on the Geology of Tennessee :

He says, page 34. A specimen taken from the bed of Powell's river, given to me by Senator Thornburg, was composed of :

Lead	75.00
Zinc	11.00
Sulphur	12.50
A trace of Silver and loss	1.50
	100.00

Another from a ridge near Powell's river,

Lead	40.00
Zinc	29.00
Sulphur	15.00
Iron Oxide	6.00
Carbonic acid and Silica	10.00
	100.00

A third specimen, from same vicinity,

Lead	53.00
Zinc	15.00
Carbonic acid	6.00
Sulphur	11.00
Iron Oxide	13.00
Loss	2.00
	100.00

I will remark in conclusion, that when galena is found alone, it generally contains 89 per cent. of Lead and 13 per cent. of sulphur, also containing, as in the Elizabethton and New Market ores, a trace of silver. And where galena is found thus, alone, the value of the deposit depends solely on the quantity of the ore.

COPPER.

Considering the very recent date since the first discovery of Copper ore in Tennessee, the rapid developments following thereupon afford another striking in-

stance of the readiness with which capitalists will enter upon such explorations when once convinced of their importance and value.

Copper District.—The range of mountains along the eastern boundary of Tennessee is composed of the metamorphic series of rocks. They possess a N. E. and S. W. course, the strata dipping at various angles, from 45° to 90° to the S. E. It is in this range of mountains that the Copper district of Tennessee is situated. Pursuing this same general direction beyond the limits of Tennessee, the discoveries of Copper have been made in Carrol and Floyd counties, Virginia, and doubtless it is the same mineral band which extends on to Maryland and Pennsylvania. South-westward the band may be traced through the interior counties of Georgia even to the State of Alabama. There is a striking resemblance in the rock strata throughout this entire mineral region. In the Unaka mountains, between Tennessee and North Carolina, the band is found to pursue a tortuous course, only here and there presenting itself on the Tennessee declivity.

In North Carolina the metamorphic rocks underlie the older primary strata, while in Tennessee they overlie the more recent silurian or fossiliferous rocks. These metamorphic strata consist of micaceous slates, quartzose sandstones, chlorite slates and primary limestones, interstratified with beds of porphyry, cherty limestones and conglomerates.

It is in these metamorphic slates, especially between the micaceous slates and quartzose sandstones, that the veins of Copper have been found. They are indicated by the outcrops of *gossan*, which is a porous oxide of Iron, tarnished, to a greater or less degree, with thin films of some ore of Copper—most generally the carbonate.

History of the Discovery, and the Progress of the Mining of Copper at Ducktown.—Having thus pointed out in a few words the general outlines of this great mineral zone, we shall enter upon a particular account of the early mining operations, and the success attending them in this new and productive field.

In the South-eastern corner of Tennessee, a region sparsely inhabited, and, on account of its ruggedness and inaccessibility, scarcely ever visited, the discovery of Copper was made.

During the Gold hunting excitement of a few years ago, which was vigorously prosecuted in Northern Georgia, Western N. Carolina, and the mountain districts of East Tennessee, almost every rill and branch were traced to their very source, and every alluvial deposit on their banks was washed and panned in search of this precious metal.—These explorations were vigorously prosecuted from 1830 to 1836, and during this period every part of the present Copper region was carefully examined, not only by the practical operator with his pan, but the Legislature of the State directed its Geologist, Dr. Troost, to visit this district and report thereupon at its next Session. The result of these labors is embraced in his TENTH Report. The labors of that survey were mainly directed to the solution of the question of the value of the *gold* deposits, and consequently the only end attained was “that gold is not so abundant in the Ocoee District as is generally supposed;” but of this we shall give an account when we enter upon the consideration of Gold.

Passing through the country near Ducktown, Dr. Troost noticed at several places masses of *hydroxide of iron*—which he pronounced of good quality, and possessing value, “especially in this country which is not susceptible

of cultivation, and where there is an inexhaustible abundance of wood." The sequel of this description will show that this was the out-cropping of the valuable deposits of Copper at the same locality.

Attention being thus directed to this point by the foregoing report, the foundation of Zion iron works was laid in 1849 by Mr. Duggar, an enterprising iron master from Johnson county. He erected a small furnace for making iron on the banks of Potato creek, where the ore was abundantly found. This is the site of the present Cherokee Copper mines. *The very high price of iron all through the mountains was such as to warrant a paying investment to Mr. Duggar.

The ordinary price was from eight to nine cents per lb. In March of 1847, Mr. Duggar purchased eighty acres in section 21, being a portion of the land at present belonging to the Cherokee mine, for \$20 and 200 lbs. of Iron, which latter payment was to be made when the contemplated forge should be in operation. A dam was thrown across Potato creek, and the work of the forge reached through the whole season, so that it was not until April of 1848 that Iron was produced from this establishment. At first the ore promised much. It looked well, and welded in the loop very readily. It would draw well until it cooled to a cherry red, then it would break across and in pieces. If heated to a white color, and immersed in water, until cold, it would show a very thin Copper precipitate on the surface. Sometimes the forge flame had a greenish tinge. After many trials to make a good merchantable Iron from the ore, the proprietor of this establishment began to examine the Iron out-croppings in the vicinity with the hope that a better ore could be found. Trials were made with no better success from

ore up Potato creek, and from the same range in Georgia. At length ore was found about fourteen miles across the strata to the Southeast in Georgia, capable of working into a fair quality of Iron. This ore was hauled to the furnace at a cost of \$5 per ton—the cost of coal being 23 cents per bushel. This forge continued in operation about two years, making in that time nearly five hundred tons of Iron, which supplied a large country, and considerable of it found markets at Dahlonega, Elijay, and the neighboring towns.

A single forge and tilt-hammer, with a water-blast made up this establishment, which, with the dam across Potato creek, cost about \$700.

We go back a few years in our sketch to note another peculiarity in the development of this mineral region.

In August of 1843, a Mr. Lemmons, who had been operating on this creek, was induced, by some singular appearance in the earth, to make some attempt to find the precious metal on a small branch on section nine, which falls into Potato creek. This is now the location of the Hiwassee Copper Mine. A small opening was made, and the washings were very successful. In a reddish brown and blackish decomposed rock, the supposed gold was found in large crystals of a deep rich red color. The fortunate discoverer toiled without rest the whole day long to secure the enormous treasure fortune was offering him. At a late twilight hour the precious metal was gathered up and packed; the sleeves of the discoverer's coat was filled, and secured at the cuffs by a hickory-bark withe. This greater fortune was so unexpected that nothing larger than a goose quill was at hand in which to store the gold, so that the coat was taken. Mr. Lemmons, slinging his treasure across his shoulder, moved

homeward, leaving his pan concealed in the bushes ready for another day's labor. On reaching his rude cabin, whiskey was sent for to help in the rejoicings, and mirth and joy resounded over those low mountain tops long after midnight, so that another sun found not a ready laborer. The next day the gold was again examined, and lo! its color was changed from the bright red, which was thought a sign of great richness, to a dark, dingy brown. This brought fears, and night stole the fortune of the day.—The gold proved to be red oxide of Copper in crystals. This event produced some excitement; but soon passed away, and no one knew the nature and extent of the metal thus discovered, or even its value. Some further work was done by Mr. Grant, who found several rich specimens of native Copper. This section of country, and the workings so far as were opened, was examined by a Geologist of this State, who gave a very unfavorable report of the district. Soon after this examination, the property changed owners, and the company, who purchased, explored the ground a little farther by cutting a trench up the branch, where Lemmons had found his gold. This work exposed to view the black oxide of Copper, which was not known to the persons whose enterprise had thus led them to embark in mining. Several tons of ore were broken and thrown out of the trench. A box of samples, including specimens of the rocks in the neighborhood, was made up and sent to Nicholas Haight, New York, for examination. This box, however, contained but a small fragment of ore, which was thought by the parties who opened this trench to be nothing but a dark brown and blackish valueless stone. The report upon these samples was that a single dark fragment produced 11 per cent. of Copper, and that the great mass of specimens were made up mainly of Iron.

This unexpected report discouraged the present operators. Their ardor was checked, and all mining operations suspended when a report of the "samples" became known. The season passed away, and in the last of April, 1847, a German, by the name of A. J. Weaver, from the District of Werner, saw the trench and informed the parties interested that the black rocks, as they were here called, were rich Copper ore. Mr. Weaver began the first mining under a lease, paying one fifteenth of the gross products of the mine. This arrangement was really the beginning of mining in this locality. On the first of May, 1847, work was resumed in the old trench, and ninety casks were shipped to the Revere Smelting Works, at Port Shively, near Boston. This ore was made up in two lots. No. 1 was worth $32\frac{1}{2}$ per cent.; and No. 2 was sold at $14\frac{1}{2}$ per cent. Mr. Weaver was in Boston at the time of the sale of the ore, and early the next season he left for Mexico, to explore some mines of silver, but fell by the Indians while crossing the plains. I copy a portion of his letter, dated Fort Independence, Mo., April 15, 1848, and addressed to one of the company who leased the mine to him :

"Before I left New York, I received such information from several sources, and especially from a German, who had just returned from the mining districts of Mexico, as has led me to change my plans, and attempt to reach the country of Chihuahua, by the way of the Plains. The accounts are creditable and very flattering for the mining of silver in that part of Mexico, and I thought to learn more of this region from the Santa Fe traders, who make Independence a point of traffic. I shall make gold-mining my first work. I shall have to close my engagements with your company; but should I be so fortunate as to return in the autumn, it is my intention to secure the help of my friends in Boston and work your mine. This I proposed to do this season, but the prospect of richer metals in Mexico has led me for a few months away.

"Last fall I took from your mine to Boston ninety casks of ore. Three casks were very poor, of a reddish clay, so that they were not sold. The balance were put in two lots. No. 1, of 18,750 lbs., deducting water, was worth 32.5 per cent.; No. 2, of 12,460 lbs., was worth 14.5 per cent., Copper."

About this time, in May of 1849, a gentleman from the west, came to the company, who began the original trench, and of whom Mr. Weaver leased, stating that he represented English capital, and desired to make investments in mineral lands, and accordingly a contract was made upon the premises, which only held the property up from all farther development. In this condition it remained until about the first of April, 1851, when notice was taken of the place, and several persons sought this region for a place of investment and enterprise. The following letter, from a very enterprising and zealous laborer in this field of usefulness, from Jefferson county, will show the manner in which a new country has been improved. This letter was written at the request of Dr. Charles A. Proctor, and forcibly illustrates the self-denial which the early explorers of the Copper region underwent in developing the rich treasures since found in those mountain fastnesses:

To Dr. R. O. Currey and C. A. Proctor: DUCKTOWN, 1855.

GENTLEMEN:—I came to Ducktown in 1849, scouting for Copper, and found some five or six tons in a cabin, ten feet square, on the property now known as the Hiwassee. I found the country unexplored; the School section, a property now worth a million of dollars, attracting little or no attention. Sat down in the woods to mature some plan to open and control the section. I owned, at the time, one twenty-dollar bill. After three hours' reflection, resolved upon calling a meeting of the citizens of the township, and make a speech explanatory of the value of the School section, and the importance of leasing it for mining purposes. Told the people that as soon as the mines could be opened, their condition would be improved, and that civilization, intelligence, comfort and wealth would be the inevitable results. At the conclusion of this remark, a speaker arose in the crowd and informed me that a large portion of the inhabitants had come here to get away from civilization, and if it followed them, they would run again. After the speech was made, drew up a memorial to the Legislature praying the passage of a law authorizing the Commissioners to give a mining lease on the School section. The memorial was signed by a majority of the citizens, and on personal application, the law was passed, and under it the lease was taken. In May, 1850, commenced mining in the woods.

In the same year, sunk two shafts, and obtained Copper from both of them. The excavations made did not exceed twelve feet—at that depth the Copper being found. Commenced mining at the Hiwassee mine in 1851, in connection with S. Congdon, the agent of the Tennessee Mining Company; built a double cabin, and taught Sabbath-school in the kitchen end of the establishment, aided by young Mr. Walter Congdon. We were tantalized by one of the miners, who exclaimed, on a certain occasion: "Good God Almighty! does that old mud-sucker think he can worship Jesus and work a Copper mine?" While this same miner was planning a way to pack Copper ore out of the mountain on mules, I surveyed the Ocoee river, and determined to make a road eighteen miles through an impassable desert. I had no means but a strong determination to surmount every obstacle. Going to a Methodist camp-meeting, I obtained permission to make a road-speech, in the recess of divine service. The speech over, we took up a collection, principally on credit and payable in trade. This, however, served the purpose, and on the 6th of October, 1851, the work was commenced. On the first day, three hands worked; on the second, two; on the third, worked *alone*—public opinion, strong and powerful, being against the enterprise; on the fourth day, hired a dozen Cherokees. Thus began one of the most important projects in the State—which was consummated in two years, at an expense of about \$22,000. The Tennessee Company came early to help in the enterprise—but the Hiwassee held back till fourteen miles of the road was passable for wagons. At the close of the first year, Rob't. McCampbell was employed as the engineer of the road, after which I again turned my attention to mining.

(Signed.)

JOHN CALDWELL.

This road, of which Mr. Caldwell writes, is the only outlet for carrying the production of the mines to market. It is constructed along the winding banks of the Ocoee river, and is 40 miles in length. The most picturesque scenery to be found in the State is presented along this route. From Clouds, where the road begins its winding course along the bank of the Ocoee, for a distance of 20 miles, there is an ascent of nearly 1000 feet, which makes an average of 50 feet to the mile. At no place is the grade of the road ten feet above the surface of the river, and hence there is presented to the traveller at every turn in the stream, new scenery, and apparently on a grander scale. Cascades of every variety are presented. At one time in a narrow channel, where it seems the stream

has cut through a mountain, immense masses of stone dam up the impetuous torrent, over which it leaps in a deafening roar. Then at another point, where a rapid curve is made, the opposite shore presents a vast amphitheatre, rising 1,000 feet from the water's edge by gradual steps, while just above the beholder, a tall overhanging cliff seems threatening with instant destruction. On this cliff, the genius of the Ocoee may be said to preside, and the feathered songsters in the opposite amphitheatre chaunt their anthems beside the grandeur of the surging waters. Here, as we ascend, is another point so calm, so smooth, that in the quietness of its festooned island, may be imagined a home for water nymphs. Thus alternately, the road passes by the calm and the boisterous of this picturesque stream. Although for twenty miles it is making its meandering way underneath its northern bank, yet an air line from Clouds to the mines, is probably not more than half the distance; but it is only such a line as the strong winged eagle can pursue.

At the time of my visit, I made a geological section of this route which I will briefly describe—extending it beyond the mines through Angelico Gap, to Murphy, North Carolina.

Beginning at Ducktown, for one and a-half miles as we go westward, we pass over alternate layers of mica slate, quartz and sandstone. At Brush creek, three miles, a blue slate is succeeded by sandstone thoroughly impregnated with particles of arsenical iron, similar to the rock taken from the Western Tunnel at Ducktown. The thickness of this rock is very great, sometimes constituting of itself heavy layers, and at others, presenting the appearance of veins penetrating a greyish white sandstone. We do not lose sight of it till we have reached, in the wind-

ings of the road, seven and a-half miles from Ducktown. To this slate succeeds. At nine miles, there was found a mass of gossan, which was succeeded by sandstone. To this came a blue slate, succeeded by an immense stratum of a porphyritic rock filled with rounded quartz pebbles. The base was evidently softer than the pebbles, presenting where exposed for any length of time to the weather, a porous character, the cementing substance being washed out, and leaving the pebbles adhering by a slight contact. At the 12 mile post, was a slate; at 13, a sandstone, and at fifteen a chlorite slate with cubes of iron pyrites, such as I had seen at Coqua creek in the Gold region. It here presented high overhanging cliffs. At 17 miles we had the same stratum of porphyry with quartz pebbles, and at eighteen and a-half miles was a blue slate twisted and contorted into knots of all conceivable shapes and sizes, interstratified with irregular veins of a reddish colored mineral.

At Clouds, 20 miles, a shaft had been sunk and a tunnel opened, through a grayish micaceous sandstone, and at Guerins', seven miles south of the river, another shaft had been sunk through greenish chlorite slate.

Beginning at Ducktown again, and going eastward into North Carolina, we notice at Congdon's, the *gossan* underlaid by a reddish sandstone, over which lies the mica slate, of a whitish and reddish white color. This is also the basis of the Hiwassee and Isabella mines, as well as others in this vicinity. Between these mines and Angelico Gap, the boundary lines of the States of Tennessee and North Carolina, the character of the rock strata and the general surface of the country, consisting of rounded dome-like hills and ridges, are altogether similar. No remarkable outcrop of gossan was found east of Isabella mine, but frequently the sandstone assumed a highly ferruginous character.

Reaching the summit of Unaka mountains, at Angelico Gap, another rich repast was spread before me. At my feet, but a few miles distant, lay the rich mining region of Ducktown, the whole country thronged to overflowing with ardent speculators, while farther to the West rose the towering peak of Frog mountain. To the East, the mountain heights and wide spread valleys of the old North State, presented such a scene as I had never before beheld. My thoughts involuntarily turned to the struggles of the revolutionary sires who battled hard against foes without and Tories within, and as I gazed thus alternately upon the birth-place of my ancestors, and my own loved Tennessee, I felt the strength of the tie which he feels who dearly prizes the home of his birth.

Beyond the Unaka mountains the strata possess some similarity to those in Tennessee, the only difference being in the purer metamorphic character which they acquire. At Murphy, a stratum of primitive limestone, of a snow white color, was examined, which has been noticed elsewhere.

The discoveries at Ducktown led to an examination of this whole region. Many failed in their haste to be made rich, others *hit* upon lucky spots—and localities yet remain undeveloped, teeming with treasure to the fortunate adventurer.

I am not prepared with statistical tables, showing the average yield of the working mines of Ducktown, except such as I find in the Report of the Geologist of Tennessee. But as they are imperfect, and refer to operations in 1855, they are not adduced here.

But the following analysis of samples placed in my possession, taken from the boxed ores may be of some interest:

ANALYSIS OF SAMPLES OF COPPER ORE FROM SEVERAL OF THE
MINES AT DUCKTOWN.

MINE.	COPPER ORE.	PER CENT.
Culchote.....	Green carbonate.....	21½
Cherokee.....	Red oxide.....	40
".....	Black oxide.....	26½
Polk county.....	Black oxide.....	29½
Isabella.....	Black oxide.....	26½
Hancock.....	Red oxide.....	44
East Tennessee.....	Black oxide.....	20½
Hiwassee.....	Black oxide.....	22½
Calaway.....	Black oxide.....	28½
Eureka.....	Black oxide.....	24

A sample from 2,798 boxes shipped to London yielded 41½ per cent. at \$207.50 per ton, each box averaging 500 pounds.

The sample from 7,819 boxes sold in New York yielded 25½ per cent. at \$124 per ton of ore.

Thus opening, one development after another has been made at these mines so rapidly, that they are regarded justly as the most valuable property in the State. An idea of their value may be presumed when it is stated that one mine is now in litigation in the United States court at Knoxville, and its value estimated at two or three millions of dollars.

Fourteen mines have been opened, all of which have been worked to great profit, yielding monthly nearly 1,000 tons of ore, worth about \$100,000. By reference to a map of this District kindly furnished by my friend C. A. Proctor, Assayist for the State of Tennessee, there will be noticed a regularity in the order of succession of these mines. It will be seen that there are at least *eight* distinct Copper veins, traversing that portion of the State, in a

N. E. and S. W. direction. There are doubtless others, which future researches will develop.

A Geological examination of the adjoining country—into North Carolina and Georgia in 1854, convinced me that the Copper region about Ducktown was confined to a very small portion of territory within the south-eastern part of our State, their bearing soon leading the mine into North Carolina or into Georgia. Explorations have been successfully prosecuted by Prof. J. B. Mitchell on the North Carolina veins, while in Georgia, numerous companies have been formed who have worked the veins successfully. A report is now before me of these Georgia mines, made by Prof. C. U. Shepard, who presents the developments in a very flattering light. We learn that the Geological character of the country in which these mines are to be found—Cherokee county, Ga.—consist of alternate strata of hornblende slate, mica slate, talco-chlorite slate and talco-mica slate, which possess a N. E. and S. W. direction, dipping at an angle of 22° to the S. E. The vein which has been opened lies between the talco-mica slate, and the chlorite slate, and had an outcrop of *gossan*, as is the case in the Ducktown mines. The geological character of these mines is the same as that which appertains to the veins of Copper ore to be found in North Carolina.

The Ducktown mines lie between strata of mica slate and ferruginous sandstone, and by reference to the map of these mines, it will be seen that there are several successive strata of these slates.

The gossan is the outcrop. This gossan is a porous oxide of iron. Its origin may be attributed to the action of water, washing out the more soluble salts of Copper, with which the iron was impregnated, which, sinking through

the vein, left a deposit of the black oxide and Copper smut.

The order in which the different varieties of ore occur is quite uniform. Beneath the *gossan*, first the *red oxide* is turned up, then the *green carbonate*, with occasional specimens of *silicate*, then the *black oxide*, the *grey arsenical ore*, the *sulphuret* and lastly the *Native Copper* in lumps, or in arborescent masses between laminæ of mica slate or quartz rock.

By reference again to the map, it will be seen that the veins of ore are traced in straight lines; but instances occur in which cross veins exist. In 1854, I had the pleasure of examining the appearance of one of these cross veins in the Isabella mine. The direct N. E. vein had been crossed by a vein bearing E. N. E. the effect of which was to push the direct vein out of its course, at the same time producing a fault in both.

Mineralogy.—The following description of the Ducktown ores is not inappropriate :

1. *Red Oxide of Copper.*—This ore immediately underlies the *gossan*, or when that is wanting, forms the upper surface of the vein. Specimens obtained from the Cherokee mine presented a beautiful crystalline appearance, the crystals being minute and lining the cavity of a mass of the impure red oxide or *tile ore*. The color of the crystals varied from deep red to a reddish silvery grey. The massive and earthy ore was of a brownish red. Sp. gr. 6. This ore is generally found to be very rich in metal, the two specimens assayed yielding an average of 43 per cent. When free from impurities this ore is composed of 89 per cent. of Copper and 11 per cent. of oxygen. Exposed to the air the beautiful red crystals soon tarnish, as was the case in the first opening of the Hiwassee mine, much to the discomfiture of the miners.

2. *Green Carbonate of Copper*, (green malachite.)

—This is the ore next in succession. It occurs in the mines in a variety of ways, as in incrustations with a smooth surface, or in flat masses, and also in earthy lumps.

It has a light green color, which, when scratched, is a shade lighter. When crystals are found they present a beautiful appearance.

This variety of Copper ore is found in the mountains of Russia in immense compact masses. Being susceptible of a fine polish, it is worked into a variety of purposes, as slabs, mantels, &c. A fine polished specimen, nearly two feet in diameter, was sent to the late Dr. Gerard Troost, some years before his death, and was kept suspended in a frame in his cabinet.

Sp. gr. of this ore is 4, and yielded from the Ducktown samples $21\frac{1}{2}$ per cent.

This variety dissolves with effervescence in nitric acid, without any residue, if pure.

3. *Silicate of Copper*, (chrysocolla,) is a rare variety; when found, generally encrusting some other variety, most usually the carbonate. It is composed of Silica and Copper, besides a mixture of other varieties.

Color, emerald green, of a deeper tinge on the surface than on the fresh fracture.

4. *Black Oxide of Copper*.—A variety of this oxide is called Copper smut. This is a valuable ore of Copper and is that which is most abundantly mined at Ducktown. In some of the mines I found it mixed more or less with portions of Copper pyrites.

It is of a dull black color, at times compact, but generally earthy or in masses. Its average yield, from all the mines is about 24 per cent. of metal, but if less mixed with other substances, it is capable of producing 60 per cent.

This may be regarded as the result of the decomposition of the superincumbent layers of ore and iron. When placed in heaps at the openings of the tunnels or shafts the Copper pyrites contained in it readily undergoes decomposition, forming a sulphate of Copper and iron united with the oxide of Copper.

5. *The grey ore* is a mixture of Copper, antimony, arsenic, and iron with sulphur, and sometimes contains also an important trace of silver. It is of a steel grey color, and sp. gr. 5. If heated, the fumes of arsenic, or of antimony are readily perceptible.

6. *Sulphuret of Copper*.—This is regarded by all miners as the ultima thule of their hopes, being the most productive and valuable of all other varieties. It is regarded as inexhaustible, and has been reached in several of the Ducktown mines. It is simply a combination of sulphur and Copper. Color, lead or iron grey, sometimes tarnished black. Before a blowpipe, the sulphur is driven off, and a globule of Copper remains.

Exposed to action of air and moisture, it readily undergoes decomposition, forming sulphate of Copper, (blue vitriol,) in the same manner that sulphuret of iron yields sulphate of iron or Copperas.

Its sp. gr. is 5.6, and yields 35 per cent of metal.

7. *Native Copper*, generally in plates or masses, sometimes assuming arborescent and filiform shapes. That which has as yet been discovered at Ducktown is in the arborescent form. It is very ductile and malleable, and often contains a trace of silver. One specimen analysed, yielded decided indications of silver. As yet it is not found in sufficient quantity to be of any value.

So much for a mineralogical description of the varieties of Copper opened up at Ducktown.

Discovery of Copper in other Localities.—In the metamorphic slates, of which the range of mountains on the eastern boundary of the State is composed, especially between the micaceous slates and quartzose sandstones, all the localities of Copper, yet discovered, have been found to exist. Although at no other locality besides Ducktown has the ore been found in quantity sufficient to render it valuable, yet the indications are in some places very favorable. Going north, along the western declivity of Unaka mountains, fair specimens of green carbonate of Copper and the black oxide have been found not far from Tellico Iron Works, in Monroe county. I have not personally examined that region, but a few years ago a box of very fair specimens was sent me by Dan'l. Welsh, Esq., one of the proprietors of the iron works, which presented favorable indications. There is another locality on the Tennessee river, near its passage through the mountain, where fine out-crops of *gossan* are found, but as yet no explorations have been made on that property. It belongs, if I mistake not, to several citizens of Knoxville.

From this point the metamorphic rocks disappear from our State, being confined to the eastern declivity of the mountain range, but again cross over near the corner of Washington county, and may thence be traced through Carter and Johnson to the Virginia line. I do not know of any discoveries having been made in these counties; but as the State Geologist says, "I can see no reason why valuable deposits may not exist within this range."

Assay of Copper Ores.—Dissolve a weighed portion of the pulverized specimen in a small quantity of nitric acid, chemically pure—to which add one-fourth its quantity of hydrochloric acid. After a complete solution is effected, evaporate the mixture to dryness, and dissolve the solid

residue in distilled water. Taking a piece of polished steel, suspend or place it upright in a narrow test-glass; then filter the solution into the same glass, occasionally adding water to the filter, till the action on the steel plate entirely ceases. During the process of filtering, if any Copper is present it is seen coating the steel plate, being attracted to it by a galvanic process. From this it may be separated, dried and weighed, and the per cent. of metal ascertained.

In the first solution in nitric and hydrochloric acids, if any silver be present, it will be ascertained by being thrown down as a white curdy precipitate.

GOLD.

The excitement of the last two or three years in the copper region succeeded only that which had previously existed in the search of Gold.

Citico and Coqua creeks—the two heading near together in the mountains of the Ocoee district, and yet the one running north and emptying into the Tennessee, while the other runs south to the Hiwassee, with the contiguous streams and mountains, were once supposed to be the land of Gold. But though the *nugget* and *lump* have as yet evaded the search of the laborious adventurer, yet frequently smaller particles have been picked off from the quartz rock, or panned out from the deposit of the creek. It appears that originally, the search was made in the sands and washings of these two creeks; but in 1854 I found that the examinations had been carried along the streams to their heads, and diligent search was being made for the precious metal in the quartz rock and chlorite slate. I found several shafts sunk to various depths, and ravines opened so as to cross the gold vein

by exposing the gold-bearing quartz. In Whippowill mine, after knocking off a portion of the quartz, I had the pleasure of picking several fine specimens of gold, and I regarded the indications favorable to the future explorer. The surface of the country is very rugged. Its geological character pertains to the primordial; its rocky strata consisting of a quartz rock, associated with chlorite slate of a greenish color, more or less intermingled with cubic crystals of sulphuret of iron. These quartzose and chlorite slates compose alternating series with red sandstone and mica slate. Preparations were being made to crush the quartz for the purpose of extracting the gold; but we do not know how far the company progressed.

SILVER.

Independent of the trace of silver ore to be found on analysis in the lead ores of Tennessee, the late Dr. Troost describes, in his Fifth Report, for 1834, two specimens of the sulphuret of silver, found by him in the waters of the Cumberland mountain. As these are the only specimens which have been found, no one having as yet succeeded in finding the source from whence they were washed, we will give his own account:

"I had the good fortune during my last excursion to make a discovery which may eventually be of great importance. Stopping for the night at the house of Capt. Eastland, on Clifty creek, on the Cumberland mountains, he handed me some small fragments of ore. As it was night, and candle-light not being fit to discriminate minerals, I told him that I should examine it when I arrived at home; they were accordingly wrapped up in a paper and marked with his name. Next morning I left that place, and passing through Sparta, I descended to the Calf-killer creek to water my horse; my attention was there attracted by something uncommon among the gravel; I dismounted and took up the substance which had drawn my attention. Not being willing to remain longer amongst the dangerous miasmata which were rising at that time from this creek, and which had infected the whole town, I did not think it prudent to examine this place further. When at

home, I examined both these ores, and found that the fragment of Capt. Eastland, as well as that found by me on the Calf-killer, was sulphuret of silver—that of Capt. Eastland containing also sulphuret of lead; that found on the Calf-killer was pure sulphuret of silver covering and penetrating crystalized fluate of lime.

“The sulphuret of silver is one of the richest of silver ores; when pure, it contains:

Silver	87
Sulphur	13
	100

“I am at a loss to make any conjectures as to the locality of this ore. The banks of the Calf-killer, which creek takes its origin in Cumberland mountains, only a few miles (perhaps twenty) to the north of Sparta, are mostly composed of oolitic limestone—of which mention is made in this report—and this limestone is covered here and there by the sandstone of the coal formation, and no vein of silver or fluate of lime can be expected to be found in it. It is the same with the oolitic limestone, which is the highest strata of our mountain limestone series, in which I never found any metallic vein, or other mineral substance; it must therefore belong to some older rocks. The only stratum, for as much as I know, in which fluate of lime is found, is in Smith county. Now the perpendicular height of the Calf-killer is much elevated above the place where the fluate of lime is found, which is not far from the Cumberland river, about 400 feet below Sparta. I do not know from whence Capt. E. obtained his specimen—as he told me it was about fifteen miles from his residence.”

CHAPTER V.

COAL REGION OF TENNESSEE.

Passing by the consideration of any other mineral or ore peculiar to East Tennessee as well as its agricultural facilities for the present, I will next in order enter upon an examination of that portion of the Appalachian coal field lying within the limits of Tennessee.

No subject has caused greater solicitude to English capitalists, than the *possibility* that at no very distant day the coal fields of their island home would be exhausted. So rapidly has the consumption of this mineral increased for the last few years, both from the increase of population, and the extended application of steam, that

many of the mines have already failed. Some of the most scientific geologists and intelligent miners were commissioned by Government to investigate this subject, and though they differed as to the probable length of time that it would require to completely exhaust the supply, they all agreed that it was an event which must sooner or later ensue. It is true that generations may pass away before it occurs; but like a wise government, there was an immediate prohibition put upon the destruction of the waste coal at the mouths of the pits, and a tax levied on its exportation. The result of such a catastrophe is more easily imagined than described. The thousands of busy hands now engaged with her looms, and spindles, and anvils, and rollers, as well as the millions of active capital employed in keeping them in motion, will be driven elsewhere ere such an event happens; and who cannot see, in the departure of these, the fading glory of the English kingdom, and the loss of her power. This is a striking illustration of the value of this single mineral. And while even the prospect of a failure strikes English hearts with terror, may we not anticipate a bright future from the developments of this mineral in our country. From Maine to Texas, there is scarcely a State that does not possess, to some extent, portions of a coal field; while in many it constitutes the principal formation.

In the Massachusetts and Rhode Island coal fields, there are estimated to be about 500 square miles. In the Appalachian, extending from New York, through Pennsylvania into Ohio, through Virginia, Kentucky and Tennessee, and terminating near Tuscaloosa, Alabama, being 800 miles in length, with an average width of 180 miles, and covering an area of more than 100,000 square miles, there are contained, at a low estimate, one million

of millions tons of bituminous coal. In the Ohio river coal field, we have another immense basin, embracing nearly the whole of Illinois, southern part of Indiana, and extending across the Ohio into Kentucky; the entire area being not less than 55,000 square miles. In Michigan, including about two-thirds of the State, another field has been explored, of 12,000 square miles. In Missouri and Iowa, is still another of 50,000; while Arkansas and Texas each contain important fields. So that, supposing these 250,000 square miles of coal deposits to have an average thickness of 50 feet, we have no less than *three and a-half millions of cubic miles* of coal in the Union.

Two classes of coal are found in our country—the bituminous and the *non-bituminous*, or anthracite. The latter class is found only to a limited extent; being the kind obtained in Eastern Pennsylvania, and is said to have been found in East Tennessee. Though these two classes possess striking marks of difference, yet they are to be referred to the same origin. The same fossil plants have been found in each; and as anthracite is coal without bitumen, there has been observed a gradual increase of this property towards the western limit of the Appalachian field. The anthracite has been debituminized by its contiguity to the primordial rocks, and to its having been subjected to a great pressure during its formation. It is similar to, and is, in fact, natural coke.

The Tennessee coal field, being part of the Appalachian, is embraced within the limits of the counties of Claiborne, Anderson, Morgan, Scott, Fentress, Campbell, Overton, Grundy, Van Buren, White, Franklin, Bledsoe, Marion, Hamilton, and Rhea, composing the range of Cumberland mountains. These mountains are again subdivided, with local names attached.

The eastern base of these mountains, so far as I have ascertained, rest upon the inclined strata of East Tennessee—though in some places there intervenes a table-land of the silicious stratum and old red sandstone. As we cross the mountains, and in passing through the Sequatchee valley, we notice on its eastern side the inclined strata peculiar to East Tennessee; while across the Sequatchee river and on the western side, a hard, white limestone is found, lying horizontally and overlapping the other strata. This peculiarity is observable throughout this rich valley—being traced as far up as Crab Orchard. Here limestone ledges present a striking contrast with the general character of the surrounding country and may be regarded as a wise provision in the midst of these sandstones and sandy soils. This limestone possesses a peculiar structure—being composed of an infinite number of egg-like fossils; hence it has been termed *oolitic* limestone; but it possesses another fossil—the *pentremite*—in as great abundance, and it is also called the *pentremital limestone*.

This limestone is also well displayed all along the western declivity of the mountains, intervening between the shales and sandstones of the coal measures, and the old red sandstone or Devonian system below. Its absence on the eastern, and its unfailing presence on the western declivity, is a striking peculiarity. From this *pentremital* limestone to the summit of the mountains are included the coal measures. They consist of strata of coal, shale, sandstone and conglomerates alternating with each other; there being sometimes from four to six of such series in one elevation, but of varying thicknesses. While on the western declivity of these mountains, the coal occupies almost uniformly a horizontal position, on the eastern the

entire strata of coal, shale, sandstone, &c., appear to have been disturbed in some places, being tilted up into an inclined position, while in others no such action appears to have taken place, as they retain the horizontal position.

As this is a subject of interest to our citizens, I have made an analysis of several specimens of coal placed in my hands, giving, also, other analyses made at different places by other persons.

The following is the per centum of each specimen :

LOCALITY. °	CARBON.	VOLATILE MATTER.	ASHES.
1. Pittsburg.....	55	38	7
2. Trade Water, Ohio river.	69,05	21	9,95
3. Rock Spring, Ky.....	80,56	10	9,44
4. Ohio river, near Caseyville. .	69,58	19	11,47
5. Addison's br. Cum. mt.....	83,22	9	7,78
6. Anderson co., E. Tennessee..	82	10	7
7. Crow creek.....	77,70	14	8,80
8. Sewanee Mining Company...	79,56	14,21	6,25
9. Kimbrough's, Roane county.	71	17	12
10. Gillenwater's, Rhea county..	69	14	17
11. Alabama, Tuscaloosa.....	80,96	12,96	6

The analysis of No. 1 was obtained from Professor Johnson's Tables—Nos. 9 and 10 from Professor Troost's Reports, and No. 11 from Professor Tuomey's Report. No. 5 is the variety of coal brought to the Nashville market, and is of a compact structure, and possessing iridescent colors—No. 3 is from a new mine on Trade Water, Ky., 18 miles from the Ohio river.

Though it is known that the range of the Cumberland mountains belongs to the coal measures, yet so little has been done for its actual exploration, that it is impossible to say where, in particular, coal is to be found. So important an element is it to become in our State welfare, that it is highly necessary that a thorough examination

of this field should be made, with accurate analyses, accompanied with a special map, and sections of the entire region.

In the table of analyses I have presented specimens from those localities which are most abundantly worked. There are many others opened for the supply of their immediate neighborhoods.

In the *Raccoon* mountains, on the line of the Nashville & Chattanooga Railroad from whence it is obtained for transportation into Georgia, the coal is similar to that produced from the Sewanee mines—being soft and very readily crumbling into powder. It is admirably adapted for manufacturing purposes.

In the *Sequatchee valley* many valuable banks are opened, the coal from which is of a very superior quality. The construction of a branch railroad to the head of this valley would open to market one of the most productive valleys, as well in agriculture as in coal, to be found in the State. In the vicinity of Pikeville alone there are no less than six banks, all of excellent quality.

In *Walden's ridge*, which separates the Sequatchee from the Tennessee, coal seams are found extending from one declivity to the other; that on the eastern declivity affording the coal for the supply of the Chattanooga market.

The coal which is brought from *Poplar creek* and other localities in Anderson county, for clearness, purity and value, surpasses any coal that we have yet examined. In many instances it is beautifully iridescent. It is this coal which is brought to the Knoxville market, a distance of sixteen miles by wagon, and by water a distance of about two hundred.

In *Cross mountain* and in the Elk river valley, valuable banks are found. To the west in *Morgan county*, there

is an inexhaustible supply, only awaiting some facility for transportation to market, to render these excellent stock-raising lands as valuable for their mineral resources.

The opening of these banks, and the construction of railroads for its speedy and constant transmission to points, both East and West, would, in a few years, tell upon the industrial pursuits of our citizens. The construction of such a road as is contemplated in the Nashville and Knoxville Railroad, and especially if continued to the Mississippi river, would draw out from these rich store houses, treasures that would inspirit the loom and the anvil with new life, and accelerate the speed of the plough. The construction also of the Kentucky Railroad, necessarily passing through the rich coal and iron banks of Anderson, promises a bright future for the manufacturing interests of East Tennessee. This is a subject in which the whole State feels a deep interest, relating, as it does, to State aggrandizement and domestic comfort. Placed in juxtaposition with the iron and the copper, no one can fail to see what the results of their development would be. Not only would capital flow into the country, but population also; until the State would become the Keystone of the South, as Pennsylvania is of the North.

In these coal measures, good millstones can be obtained from the conglomerates, and gridstones from the sandstones; while the strata of reddish and of white clay would answer admirably for burning into fire brick and fire stones.

In the decomposition of the aluminous shales and limestones in many of the caves, rich deposits of materials for the manufacture of alum, and of saltpetre are found, while the iron ores and coals in close proximity present an unsurpassed field for enterprise and the investment of capital.

Geological Position of the Coal Deposits.—This formation is composed of alternating series of argillaceous shales, micaceous sandstones, and coal. They occur above the rocks of the transition, or silurian period, and below those of the secondary period. On the one side the fossil ferns of the coal strata is lined with the trilobite, the euomphalus, and the extensive family of the crinoidea; and on the other with the remains of the gigantic saurians—and their foot-prints impressed on the new red sandstone.

The characteristic fossils of the coal measures are fossil plants; such as stigmaria, sigillaria, lepidodendron, calamites, with many species of ferns—all beautifully impressed on the clays and shales, and sometimes even the coal itself has presented the fibrous character of the wood. In the midst of the dense and majestic fern forest, as it originally grew and flourished, the only reptiles whose remains have as yet been discovered, the *cheirotherium* and *apateon*, stalked sole lords of their forest home.

Utility of Coal.—On this subject I introduce a few extracts from a report made by Charles Ellet, Esq., President, to the Schuylkill Navigation Company:

“This is essentially the age of commerce and of steam—the foundation of which is our *coal mines*.

“Each railway requires iron for its track, engines, cars, and frequently for its stations. Each new steamer requires coal to drive it—iron for its engine, and sometimes for its hull; and five tons of *coal* for each ton of iron it consumes.

“The manufacture of the iron, and the propulsion of the machinery require *coal*; the quantity increases with the expansion of the railway system; the system extends the area of civilized population, and consequent agricultural wealth. This wealth needs transportation, and this transportation again needs coal and iron.”

And as another report remarks:

“Mineral and metallurgic industry is, with agriculture, the most vital element of our country's prosperity. COAL is the most essential agent of all industry; the foundry, the iron, constitute merely the instruments, the elements of riches.”

Palæontology of the Coal Measures.—This department of geology has not been developed to a sufficient extent in Tennessee to afford us a complete view of the fossil remains found entombed within it. But whether examined in the United States, in Europe or in Asia, these measures have always been found to contain the same classes and species of fossils; so that it is presumable that many more than have as yet been discovered, lie imprinted beneath the strata as on a page—the unread history of another epoch.

No one, at the present day, doubts the vegetable origin of coal. Its geological position; its chemical composition; its organic remains, each affords evidence of this fact. Sometimes entire beds of coal are composed of small leaves; and at others the trunks of trees are turned up in a carbonized state. Some varieties of coal on the fresh fracture present the appearance of charred wood, possessing a glossy, soft and fibrous texture.

The character of the extinct flora indicate a vegetation that belongs to a tropical climate—and that delights in low, swampy localities; the corresponding species to be found at present in our temperate latitude being of stunted growth, and rather herbaceous than arborescent.

During some powerful convulsion of nature, these gigantic forests were suddenly engulfed or entombed, and the process of carbonizing went on gradually for ages, till, in the course of time, as in our coal field, another of those revolutions which have marked the surface of our planet, elevated our Appalachian chain of mountains, the waters drained off, and left, far out on land, this immense deposit of a mineral, adapted to the wants, that were to be, of man—the last act of creative agency.

Thus prepared, these carbonized masses of the remains

of earth's primeval forests are, by the development of art and science, once more unlocked, and made to perform a new part in the economy of nature. The elements of their composition are disengaged to illuminate the crowded city, and employed in thousands of operations devised by the ingenuity of man. The characters of the plants of which it is composed, are read in the leaves and in the fruit, in the trunks and in the roots which have escaped destruction during the process of carbonization. And the remains of the only two animals which are as yet known to have enjoyed the grandeur of this primeval scenery, are traced out in their tracks and in their fossils—the mute interpreters of things as they once existed.

The fact that there are found successive layers of coal, clay and sandstones, may be accounted for on the principle of what we see going on in the deltas of our rivers, and in our alluvial deposits, that of the rising and falling of the waters, and the periodic accumulation of drift. According to this, those parts of the plant which could float would be found at the uppermost part of each layer, while the heavy and water-logged trunks, perhaps still attached by their roots, would carbonize in the lower strata—in short, would constitute the coal itself. And such is found to be the case. The argillaceous slates are, in every seam, imprinted with the leaves and fruit and stems of the flora, while lower down the trunks and lower parts are imbedded, in some instances, in the coal itself.

The leaves of several species have been found, together with the roots, trunks and stems of others. Suffice it in this sketch merely to designate these without any special description or classification.

Of leaves we have, belonging to the ferns, the *pecopteris* and the *sphenopteris*, the stems of the *calamites*, the stems

of the *sigillarias*, and their roots the *stigmarias*, the *lepidodendron*, and the *asterophyllites*, (the star-like fern,) besides stems and leaves of the *coniferæ*.

So regularly and distinctly are these fossil flora imprinted on the fine grained slates that they appear as the work of art; they are, in fact, nature's lithographs.

CHAPTER VI.

MIDDLE TENNESSEE.

The geological observer, as he passes in his explorations over each successive stratum composing the various formations of a district, has at his command at least three characteristics by which the different strata, especially when interrupted by mountains or ravines, may be classified and referred to a common origin. These characteristics relate to the chemical constituents of the rock strata, their relative position, and the organic remains or fossils imbedded in them. He experiences no difficulty in forming a conclusion by the application of the first two tests; but in order to satisfy himself of the correctness of that conclusion, he must thoroughly read the history imprinted on that rock by the animals which existed at the period of its deposition. These three tests, therefore, enable him in a scientific manner to group together the rocks of a district in established formations. We have so far in our sketch had but little to say concerning this mute language of our geological formations, though the field over which we last passed was, in this respect, of no ordinary interest.

I pass now to the consideration of a new field, differing in the position of its strata, as well as in their characters, from those in East Tennessee, and in the coal measures; not so rich, however, in *mineral* resources, yet

embracing within its limits abundant materials for individual enterprize. Here, too, the fossils of these middle counties, lying between the *base* of the Cumberland mountains and the Tennessee river, so numerous and so varied, render this as classic ground for the naturalist.

The traveler, on descending from the heights of the Cumberland mountains, the carboniferous formation of our State, finds, as he continues his journey towards the city of Nashville, a series of rock strata, each successive one being so much lower than the others. These strata are also found to differ in several other respects. If, then, he should pass beyond this point in any other direction, North, South, or West, he notices that he gradually ascends in like manner until he reaches the high lands, of a similar character to those at the base of the mountains.

The conclusion naturally forces itself upon his mind, that Nashville is lower than the surrounding country. This is true in a geological, though not altogether in a topographical, point of view.

I will therefore take the city Nashville as a starting place, in order to give a general description of the surface of the country under examination. Beginning at low water mark of Cumberland river, under the bluff, there is observed a thick stratum of a deep blue or blackish limestone, characterized by a small number of fossils—containing regular lines of flint-nodules, some of which are round, possessing imitative shapes, and others extended in thin layers. Tracing this stratum, it is found to disappear as we descend the river, possessing therefore a slight inclination to the N. W. On ascending the river, however, it is seen to rise higher and higher above the low water level, causing the natural inference, that it

must, at some point to the S. E., become a surface rock, and as such it is noticed at Mill creek, and in Rutherford county.

This same gradual rising of the blue limestone is noticed in the cuts along the line of the Nashville and Chattanooga Railroad. Around the vicinity of Murfreesboro' it is found as a surface rock, but as we proceed towards Nashville it gradually sinks, till it disappears under other overlapping strata of limestone. Occurring therefore as the lowest limestone stratum in Middle Tennessee, one of two causes have operated to expose it to the surface; either the superincumbent strata have been washed away, or some gradual upheaval has given to it a higher geological altitude at one point than at another. The rounded appearance of the stratum would clearly indicate this elevating cause.

Returning to our starting point, the succeeding strata are composed of grey and blue limestone alternating, not so compact, but of a more crystalline character, containing numerous cavities filled with beautiful crystals of various mineral substances—such as carbonate of lime, sulphate of strontian, sulphate of barytes, sulphate of lime, and quartz. Beautiful cabinet specimens may be procured from newly opened quarries. These strata embrace the rock from which is obtained the blue limestone for the foundations of our houses, and for burning into lime. It contains its characteristic fossils, more numerous and somewhat different from the preceding, evidence of its belonging to a different group. Overlaying these strata is another, which, on account of the great number of shells of the *Orthis* genus, might be distinguished as the *Orthis* limestone, the entire rock in some places being a mass of agglutinated shells. Just above this stratum

comes another which is abundantly found in some places, but appears to be somewhat isolated, though the connection of the various beds may be easily noticed on opposite sides of intervening valleys or ledges. From this stratum is obtained the large and inexhaustible quantity of ash grey limestone, used for building purposes in the city of Nashville, of which the capitol and several public buildings are constructed. The State quarry in that vicinity opens to view a thick stratum of this limestone, one of the most interesting localities for geological observation. Overlying this stratum is another of limestone of a compact structure, easily pulverized, breaking into flat, and somewhat conchoidal pieces, of a grey color. It is preferred for the purpose of paving and Macadamizing turnpikes, on account of the readiness with which it breaks up, and the fine surface it affords when cemented together. And the last and highest in these series is a stratum possessing a yellowish color inclining to grey, well characterized also by fossils. It constitutes the uppermost stratum of the lower Silurian rocks in that region. All the rocks between this and the first stratum noticed, belong to the lower Silurian system, though they may be sub-divided into groups, and named according to the prevalence of each in certain localities. This entire limestone region embraces the interior counties of Middle Tennessee, possessing an area of about one-half of this district.

This stratum is about two hundred feet thick, and is of a very mixed character, sometimes being silicious and then argillaceous. "Part of it is composed of small, often very fine and uniform grains of quartz or sand, rarely containing any argillaceous or ferruginous cement, nor does it contain any intermixed mineral. Its color is mostly grey, passing into yellow or yellowish brown. The tex-

ture, sometimes granular, often passes into earthy without losing its silicious nature, resembling tripoli; and sometimes it is slaty and again passes into chert."

Surrounding it, there are a series of elevated ridges which generally take their name from the water courses which originate in them, Caney Fork, Elk, Duck, Harpeth, and White's creek ridges. They observe no particular direction, but surround this limestone region, presenting at places bold escarpments, like the walls of a fortification. These strata are of a more recent origin, and consequently are superior to those just passed over, and belonging to the upper Silurian, Devonian, and Carboniferous systems. The first group consists of several members of limestone rocks, which crop out at the base of some of these ridges, while in others they are wanting. They possess colors ranging from grey to blue. One member being of variegated colors, with red and green spots, and plentiful crinoideal fossils, and somewhat compact in structure, would afford an excellent marble. I have examined a locality some ten miles to the West of Nashville and incline to the belief that it would, on further exploration, be found an extensive and valuable stratum. It is susceptible of a fine polish, the encrinital stems scattered profusely through it, giving to it a beautiful appearance. Next in order in these ridges is found the black shale or slate, of various thicknesses, of an aluminous character, sometimes so highly charged with bitumen as to lead the uninformed to suspect the existence of coal. The iron pyrites, which is sometimes found in it in great abundance, renders it valuable as the source for the manufacture of Alum, Salts, and Copperas.

To this succeeds a stratum, denominated by our late geologist Dr. Troost, as "the Silicious Stratum"—it con-

stitutes the uplands, and embraces nearly one-half of the entire district. Constituting the table land at the base of the Cumberland mountains, it is occasionally prolonged farther Westward in spurs, while at other places the mountain streams have cut deep ravines through it to the depth of the limestone beneath. Extending into North Alabama, and again entering our State and occupying all that region embraced by the counties bordering on the Tennessee river on the east—it surrounds as a zone or girdle the fertile limestone counties of the interior. This extensive stratum belongs to the Carboniferous system, and is composed of several members—a silicious stratum, and a calcareous sandstone. The water courses, originating in the interior, have cut their way through these strata, exposing the limestone and black shale below. These strata terminate before reaching the Tennessee river—the channel of this stream being upon the upper silurian limestone. About ten miles to the West of this river the entire systems of Middle Tennessee is lost under the Cretaceous system of the Western District.

In the examination of the various soils, there is observed a constant change as we pass from one variety of rock strata to the other. They also influence the growth of the forest-trees, and are of no little importance in the productions of the farm.

Minerals of Middle Tennessee.—We have already noticed the iron banks and iron manufacture of Middle Tennessee. It is one of its most important resources, while at the same time it is the most important metalliferous mineral found in this region.

In the aluminous shale of the silicious stratum may frequently be found deposits of aluminous earth, in quan-

tity sufficient to compensate for the investment of capital. Near the Old stone fort in Coffee county, I have examined a fine locality of this mineral.

I might also notice the tripoli of White's creek ridge, and the fluate of lime of Smith county and the gypsum or sulphate of lime of Summer county—together with localities of copperas and nitre along the base of the Cumberland mountains, but none of them have as yet been supposed to possess sufficient value to render them profitable.

Palæontology of the formations belonging to East and Middle Tennessee.—To present a view of these to their full extent would require a volume of no ordinary size. The late Dr. Trcost properly designated the limestone strata, belonging to the silurian formations of our State, as classic ground for the naturalist. Just previous to his death, he had prepared a memoir on the *Crinoidea* of Tennessee, which he submitted to the Regents of the Smithsonian Institution as a scientific contribution. It was accepted but what has become of the manuscript I am unable to say. It should, by all means, be given to the scientific world, for it not only embodies the labors of our most indefatigable Geologist, but also is the only key which has as yet been prepared for interpreting the formations of our State.

There is not altogether a close correspondence between the fossils of East and of Middle Tennessee, there being many genera and species found in the one not possessed by the other.

In East Tennessee, the crinoideal fossils in the strata of variegated marble, and the trilobites and the euomphalus of the greyish limestone, are quite characteristic; while in Middle Tennessee, the conotubularia, and the ortho-

ceratites, the calamipora and the catenipora, the terebratula and turbo of the blue limestone, the venus and belerophon of the granular white variety, and the orthis of the grey, are also characteristic, and the limestone which is found contiguous to the *silicious stratum*, and which possesses an oolitic structure is characterized by an abundance of the pentremites and encrinites. Perfect specimens of each have been gathered in Franklin county. Dr. Troost regarded the *strombodes* as also characteristic of these strata.

With regard to the age of these oolitic limestones, there is no doubt, from the identity of the fossils peculiar to the two stratifications, that it is coeval with the silicious stratum. The aluminous slate which intervenes is devoid of fossils.

This enables us also to determine the period of the deposits of iron ore peculiar to these strata. Dr. Troost advanced the idea that they were posterior to the strata in which they are found, but anterior to the greensand of the Western district; for in Perry county the cretaceous strata overlie the deposits of iron ore.

Middle Tennessee was also the home of the Mastodon and Megalonyx. The bones are generally found in alluvial deposits. I have in my possession several teeth, a portion of the lower jaw and several ribs of a Mastodon which was dug up in Wilson county. They were found while excavating a well, eight feet beneath the surface of the ground, and lying in between the crevices of the limestone rock. In the same crevice was found a large quantity of semi-carbonized wood, and among the debris thrown out, I picked up a pine buhr. There is now no pine nearer than the Cumberland mountains, one hundred miles distant. The wood also possessed the structure of pine.

The animal, it appears, became wedged in the crevice and there died. I have been informed that other fragments have, since my visit, been dug up. A large elm tree was growing upon the spot.

CHAPTER VII.

CRETACEOUS SYSTEM OF WEST TENNESSEE.

The Western District presents to our investigation a field entirely different from the other portions of the State. The formations peculiar to Middle Tennessee pass to the west of the Tennessee river, and disappear under the West Tennessee strata. The line, where this change takes place, varies in its distance from the river, averaging, however, about three miles, conforming to a certain degree of longitude. All the space between the river and the line where the cretaceous strata first make their appearance, is a bottom land, and, when of sufficient width, admits of fertile fields. Occupying the foundation of this bottom or low land, are the limestone strata of Middle Tennessee, to which succeed the system which is now to engage our attention. These strata are called cretaceous, because among its members is included chalk, while the others also partake of that nature. There is, however, no chalk in the United States.

An examination of this system in our State reveals but a few of its members, yet they are of such importance as to render the district in which they are found, highly interesting, not only for the richness of its soil, and its agricultural facilities, but for the value which will, at no distant day, be attached to one of its beds, being the storehouse from whence will be obtained the material for the renovation of the soil of the surrounding country, and thereby prolong its capability for sustaining the population to come after us.

A singular feature is observed in the physical geography of West Tennessee. Two large rivers, whose currents flow in opposite directions, bound it on the east and west. There must consequently be an intermediate ridge of high lands, to separate the tributaries which flow to the one, from those of the other. And from this high land there must be a gradual inclination to admit of a natural drainage towards these two streams. It is noticed, therefore, that after crossing the Tennessee, a succession of high hills skirt along the western bank, at an average distance of three miles from the river. Ascending these elevations, the surface of the country appears to rise gradually higher for about ten miles farther Westward, from which point the slope is in an opposite direction—this is the dividing ridge. Beginning at the Mississippi line, it is found to extend into Kentucky, the pleasant towns, Purdy, Lexington, Huntingdon and Paris, being nearly on the summit of the ridge, and nearly equi-distant from the Tennessee. While, therefore, the tributaries of the Tennessee are small, owing to the short distance they have to flow, with the exception of the Big Sandy, which though rising in the same ridge, runs a parallel north course with the Tennessee for nearly two-thirds of the width of the State, before it empties into that stream—those which rise on the western slope, after pursuing very serpentine courses, and gathering numerous streamlets into their channel, enter the Mississippi, some of them important navigable streams. Of these are the Wolf, the Loosahatchie, the Hatchie, the Forked Deer, and the Obion. So numerous are the small streams which become tributary to them, that the whole district presents the appearance of net-work—an arrangement highly conducive to its agricultural facilities. In pursuing a line

of observation from the Tennessee River to Randolph, on the Mississippi, we note the following peculiarities. At the distance of about five miles from the Tennessee, there is observed a series of hills—not contiguous ridges, skirting along the stream, each hill appearing isolated with rounded summits. Where washings have taken place, successive strata of blue marly limestone, white and red clay, and argillaceous sandstone, are exposed to view, cropping out from the western declivities, or between these rounded hills. The highest of these points is familiarly known as Pilot Knob, and is supposed to be at least 400 feet above the level of the river. These strata are seen to dip towards the north-west at an angle of 20° lying upon the strata of the Tennessee river, and forming, by their inclination, a basin for the entire strata of West Tennessee. I will presently allude to an important fact relative to this underlying limestone stratum.

These limestone strata remain as the surface rock, except where covered by soil, until we reach Camden, where they disappear under a white silicious soil. To this point there is a gradual ascent, but to the west of it the surface of the country gradually slopes to the bluff at Big Sandy. This bank or bluff is neither so high nor so abrupt as that at the Tennessee river and is composed of the same white sandy soil. Passing over the low lands skirting this river, we observe, as we begin to ascend to the table land, a reddish clay soil, which readily crumbles, while above it we again come upon the white soil. Here, as on the Big Sandy, it constitutes the surface soil of the elevations. Descending thence to Huntingdon, we notice the red soil which again disappears under the same white soil, on the elevated point near McLemoresville. Thus alternating, the high and table lands present the same ap-

pearance to the Mississippi, except when covered over by the rich black alluvium of the river low lands. The successive strata passed through in sinking wells have exhibited the same white clay, red clay, blue marly limestone and white sand. These wells have been sunk to the depth of 100 feet. I do not know whether any attempts have been made to procure *Artesian wells*, but from the general structure of the country, the inclination of the strata, lying also upon the slightly inclined strata of Middle Tennessee, would seem to favor the idea that if borings were made to the depth of 400, 500 or 600 feet, a stratum would be reached from whence water would flow forth. The success of such an experiment would be of incalculable benefit to the country.

In the south-eastern counties, we find more fully exposed to view the marly limestone and the green-sand strata. These strata form almost entirely the surface of McNairy, extending also into a portion of the adjoining counties, but soon disappear under the surface soil. Here is presented another feature in the physical geography of this district. Extending from the Mississippi to the Tennessee river, through the northern counties of the State of Mississippi, is an elevated ridge which divides the waters of that State from those of our district. Towards this ridge the strata of McNairy and Hardin counties point, thus giving to them a dip to the north-west—at the same angle of 20 degrees. It is easy to imagine therefore a basin existing in the north-west counties. And that is in the vicinity of New Madrid, the seat of volcanic action in 1812.

The seventh report of our geologist contains an account of the green-sand of McNairy county, which is said to be “in the form of small dark grains of the

size of gunpowder, of an olive or blackish green color not gritty, but easily crumbled between the fingers." Sometimes these grains merely adhere together in lumps, but then again are cemented by the calcareous matter of the marl. The analysis of the green sand shows it to be a true silicate of potash, the principle ingredients being silica, potash, carbonate of lime, alumina, and protoxide of iron. The marl also contains an important proportion of carbonate of lime, the two deposits in this respect differing from the New Jersey marl. In these marls and green sands, *as well as in her productive soils*, consists the wealth of West Tennessee. The immediate spots where they form the surface rock, may be unproductive, but it is the unproductiveness of excessive fatness or richness. Marls or green sands only display their wonder-working properties when placed within the influence of organic matter. They are mineral manures, and to promote the growth of vegetation there must be in the soil a proportion of decomposing vegetable matter with which it readily forms soluble compounds. Their beneficial effects are observable, as well in renovating worn out lands, as in tempering the quality of black alluvial soils. To the first, they will restore the proportion of lime and potash which an exhausting system of tillage had removed in the form of crops—to the second, they will serve to open the mass of vegetable matter, and, by forming new compounds, warm up the cold alluvium, and render it fit for cultivation. The system of agriculture generally pursued in new countries, is conducted, by reason of the natural productiveness of the soil, with so little reference to scientific principles, that it is only in those countries where a constant tillage has exhausted the soil of all its powers to produce, that

the application of science shows what rich treasures nature has provided for the wants of man. Nothing is truer than that a succession or rotation of crops is necessary to preserve the energies of the soil; and that if the same production is raised for several years upon the same field, it gradually degenerates, at last yielding no fruit to reward the husbandman for his toil. The plant takes up from the soil only those ingredients adapted to its well being—but, like the impoverished animal, where these are wanting, it will feed upon those things which may be detrimental to its growth, and cause it to sicken and die. The analysis of soils shows what they are capable of producing, and enables the farmer to apply the appropriate fertilizer for rendering them productive in the highest degree.

Minerals of West Tennessee.—The *Iron deposits* are also found to pass beyond the Tennessee river and afford excellent banks in Benton and Decatur.

The *green-sand* or *marl*, which mark the geological character of McNairy, Hardin, Hardeman, Henderson and part of Madison counties, consists according to an analysis made by Dr. Troost in 1843, of

Silica	48.00
Alumina	7.00
Protoxide of iron	20.70
Potash	10.10
Carbonate of lime	5.70
Water	8.00
Loss	50
	100.00

The thickness of these beds is supposed to be nearly three hundred feet.

Hydraulic limestone is found in Hardin and Decatur counties, the stratum being about sixty feet thick. It is of a light blue color, and in horizontal layers.

Lignite, an impure variety of coal, being of recent origin may be naturally supposed to occur in the *bottoms* along the Mississippi river. It is formed by the successive deposits of mud, sand and vegetable matter, during the overflows to which the Mississippi is subject, and is more or less carbonized according to the age and depth of deposit.

White clay, of service in the manufacture of pottery of all qualities, occurs in abundance in all the interior counties of West Tennessee, and may at some day become an important branch of industry. In many localities it will also afford an excellent article for making *fire brick*.

Palæontology of West Tennessee.—The cretaceous formation of West Tennessee is characterized by many interesting fossils. They are of more recent species than any yet noticed, and belong to several genera. Among the Mollusca, we find the *Ostreas*, the *Gryphea*, the *Exogyra*, the *Hamites* and *Baculites*; and among the Crustacea, the *Calymena* and *Asaphus*, besides several species of Zoophytes.

I have now traversed the State in its entire length. It will be seen that it is varied in its physical configuration and in its geological formations. It is also as varied in its climate, and in its agricultural resources. Its fossils we have also seen ascend from the most ancient to those of a modern period—from those long since extinct, to those which have representatives flourishing at the present day.

There remains but one more subject for me to discuss, which I will do briefly in the following chapter.

CHAPTER VIII.

AGRICULTURAL GEOLOGY OF TENNESSEE.

One of the most important benefits which the science of Geology, in connection with chemical analysis, has bestowed upon man, is the development which it has made in its application to agriculture. It is no less true that agriculture is the basis of wealth, than that the agriculturist is the benefactor of his race. What matters it how productive may be the mines of copper and zinc and iron, or how extensive and accessible the beds of coal, if the earth refuses to yield her fruits. The development of our mineral resources will cause the population rapidly to increase, demanding in turn increased productions from the soil for their support. That we have fertile fields, none will doubt; but that these fields will of themselves continue so, none will hardly believe.

The science of Geology is intimately connected with the art of husbandry. It makes us acquainted with the character of soils and the tillage best adapted to each. By reference, therefore, to a truthful geological map of any district, its agricultural capabilities may be clearly inferred. The formation of a soil is owing to the disintegration of the rock strata underlying it.—Therefore if limestone is the prevailing rock, the soil will partake more or less of a calcarous nature; if it is a sandstone, the soil will be sandy, and if shale, it will be clayey. None of these soils, consisting of a simple ingredient, would be productive to any great extent; but a truly fertile soil must be composed of proportions of several mineral ingredients. Hence it is that in those

countries where two formations come together, there we find the soil to possess the greatest fertility. Thus clay and lime would, properly intermingled, afford an exceedingly rich soil.

It is an admitted fact, that lime bears no unimportant part in the productiveness of the soil. Geology teaches us, therefore, from whence this lime is to be obtained, as well as what districts require this fertilizer. This lime may be applied either in the state of phosphate, and obtained from calcined bones—in that of calcined lime and obtained from the limestone rock, or in that of gypsum or sulphate of lime, and obtained from the plaster beds. Soils consist generally of three parts, first a thin stratum of dark mould which is decaying vegetable matter; second a black earth, an intermixture of the vegetable mould with the peculiar soil of the country, and third, an underlying stratum of red or yellow clay. Judicious cultivation mixes the three varieties together, and by preventing an exhaustion of any one ingredient, preserves its fertility. This judicious cultivation consists in a constant rotation of crops, and deep ploughing, with the application of the several manures within our reach.

In an examination of the different portions of Tennessee, there is found as great a variety of soils as she has geological formations. Let us examine each separately.

In East Tennessee the inclined strata of the different limestones, shales and sandstones, afford a rich soil, well adapted for the products of the farm. Composed of a series of valleys and mountain ranges, it is well calculated for the growth of the cereals and grasses, in which a large share of silica is required to perfect the plant in all its parts.

The valleys are very productive, yielding almost with-

out a failure, crops of wheat of excellent grain, while the ridges and mountain sides are capable of supporting a fine pasturage for the maintenance of stock.

The sandy elevated lands of the Cumberland mountains produce fine pastures of grass and are also well adapted for stock raising.

But the truly agricultural region of Tennessee is confined to the central limestone basin of Middle Tennessee and to the Western District.

The central counties of Middle Tennessee possess a soil of a black color, varying in depth from one to three feet, and lying upon a substratum of reddish clay. This soil is a mixture of sand and disintegrated limestone mixed with vegetable mould. These lands, for the growth of corn and blue grass, are unsurpassed.

In West Tennessee, unless where the excessive richness of the marl lands prevents a growth of vegetation, the soil is rich and well adapted for cotton and corn. Here we are furnished with a substance for enriching the worn out lands of the other portions of the State. This marl is, in New Jersey, an article of great profit, many farmers having, by means of it, already reclaimed their exhausted fields. It is destined at no distant day to be an important element in the wealth of Tennessee. Contiguous to the silicious stratum of Middle Tennessee, which is generally of a sandy character, by its means the ridges may be brought to a degree of fertility equal to the limestone counties.

East Tennessee is also well situated with respect to the plaster beds of Western Virginia—much of it already finding its way down the Holston.

To sum up, therefore, the wealth of Tennessee consists in the mines of iron, copper and zinc; in her banks of coal

and her strata of marble, in her nitre caves and black slates; in her forests and fields of waving grain; her fruitful valleys and mountain grazing lands; in her marl and hydraulic limestone, and in her innumerable mill-sites along streams of excellent water power. And by means of the lines of railway, which it is hoped will one day connect the divisions of the state together, great facilities will be afforded for the transportation of her varied productions from one part to the other. The cotton of West Tennessee may then be manufactured in the Middle or Eastern Districts, and the iron and glass, the grain and the hemp of the eastern portion, be returned to it.

I regard our agricultural operations as the basis, the solid foundation upon which our national prosperity rests; yet to ensure this, and render them effective, there must be a co-operating agent, and that is the *manufactory*. An agent, working along by the side of the farm, ready to take up the raw material and convert it into a suitable form for use.

I use the term manufactory in its broadest signification—embracing all the mechanical trades—in which the raw material is converted into the forms adapted to the varied purposes of life.

It is the duty of Tennesseans to make use of the great advantages that the God of nature has placed within their hands, and their interest demands that they should themselves work up into that form which is the most valuable and attainable, the bountiful productions of their State.

Take the article of wheat. Why can not as good flour be made within our own limits, as that obtained from abroad? Our wheat crops are generally excellent, and by due attention and the proper management and prepar-

ation of the soil, can be made equal to any in the country. Those mineral ingredients required by a soil to produce wheat crops, exist in our soils, and where defective, we have in our limestone, and in our dense forests, and in sand hills, all that is needed to remedy them. Now what is the advantage gained by producing and manufacturing our own wheat? Simply this: We not only give employment to a greater number of operatives, and thereby increase the demand for food—the productions of the farm, but we are putting every part of the grain to good use. While the cost of transportation of flour is no greater than of the wheat, and while the value is thus increased, we can employ the refuse of the mill to good purpose. The starch thus obtained is valuable, and meets with a ready sale, and the digested bran would be readily fed upon by our stock, and also is valuable as a fertilizer of the soil. Our wheat then is worth more to us in the form of flour than it will command in the grain.

Take our iron. No one would think of transporting the ore, yet how often is it that pig iron and blooms are carried from one part of the country to another for manufacture. It is a heavy article at the best, how much more when mixed with its impurities? Common sense, therefore, would teach us to erect our furnaces and forges just where the metal is found, or as near it as possible. But the rolled or hammered iron is not the most valuable form, for while one pound of it is worth but a trifle, it is capable of being manufactured into a thousand articles, needed in every department of industry, and thus increasing the value of the pound of iron more than one thousand fold. For several years, much of the railroad iron was imported into this country, and yet there are inexhaustible beds of as good ore in Tennessee as can be found in

the world. In the system of manufacturing which we wish to propose, there will be largely needed this valuable boon of Heaven, to prepare the ten thousand spindles, the cranks and levers, the wheels and boilers and machinery, which will be put into operation.

Copper has been found in one county, and zinc in several others. Either of these separately or both combined to form brass, will be valuable. Why not then manufacture them here at home, at the place of deposit?

We might refer to cotton and Indian corn as additional examples. Now, the establishment of these manufactories and mills of every description would have the tendency to arouse the energies of the people, to quicken their inventive genius, to concentrate their capital, and to enhance it, to cause an influx of capitalists and operatives, to create a market for the productions of the farm, and by a reflex influence, the refuse of all such consumption being returned to the soil, to increase its value.

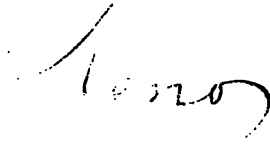
In 1813, when the first factory was established at Lowell, Mass., no one saw in the unsettled pasture and meadow, the future great city and the extensive operations which have raised it to its present pre-eminence. An unprofitable canal around Powtucket falls was purchased, and the result has been, what the country all know, Lowell made far-famed, and its numerous companies wealthy. Now it is well known that cotton factories require either the erection of several other kinds for producing the materials requisite in their operations, or the connection with them of those several departments. We will merely enumerate these required articles that the reader may see what a system is thereby put into operation.

Thus there is glue, of which a great quantity is needed,

starch and flour, oil, lard, coal, charcoal, and wood, all directly employed in the converting of the raw cotton into thread and cloth. Add to these the large amount of food consumed by the thousand operatives engaged in the business, and are you not ready to believe that there is a great influence exerted by the establishment of manufactories? Thus is the value of land enhanced, and its productiveness increased by the demand. By pursuing such a course, it is obvious what Tennessee might become. Her waste lands would be brought into market; her unproductive farms return four-fold into the laps of their possessors; her mineral wealth appreciated; her hills and her valleys teeming with a busy and thriving population; her mountain streams and rivers made, every drop, to contribute to the wealth of her citizens; the native intellect and energies of her sons would be stimulated, and as development of mind elevates the man in the scale of being, her citizens would be rendered better and happier and more intelligent, and her name be enrolled, for enterprise as it is now for bravery, high on the roll among her sister States. This is what Tennessee must become.

I would, therefore, in the conclusion of this Geological sketch of Tennessee, point to the granite hills in the east, and the rich deposit of ores found there; to the upturned strata of East Tennessee, with her marble, alum and hydraulic lime; her iron, copper and zinc; to the Cumberland mountains, with its rich and inexhaustible banks of iron and coal; to the resources of Middle Tennessee as they exist in her soils, her extensive iron banks, her alum, slate and limestone quarries; and to the marl and clays and fertile soils of West Tennessee as affording ample fields for the investment of capital. Truly may it be said that we have "a good land, a land of brooks of

water, of fountains and depths that spring out of valleys and hills ; a land of wheat, and barley and vines ; a land wherein thou shalt eat bread without scarceness ; a land whose stones are iron, and out of whose hills thou mayest dig brass." These are the treasures of our State and her prosperity is dependent upon their development.



SUPPLEMENT.

Since the foregoing sketch was put to press, several facts have been made known to me which are introduced in this place.

MARBLE.

In the Sketch I designated the company with which Mr. Sloan was engaged in working the marbles of East Tennessee, as the *Ætna Company*. It is the *Sligo Marble and Manufacturing Company*. This company has erected extensive steam works in the vicinity of Knoxville, and near to the Depots, and are running daily four saws, each with a greater or less number of blades. The rock is quarried in immense blocks of several tons, and brought down the E. T. & Va. Railroad from the quarry, a distance of one and a-half miles. They have about fifty men engaged in the works and are producing fine specimens of workmanship.

Near Erin station, five miles west of Knoxville, on the premises of Mrs. Reynolds, another excellent quarry of variegated marble has been opened. Here is also to be found the peculiar variety which we have designated as the *banner marble*. This stratum is but a few hundred yards from the E. T. & Ga. Railroad, and a fine supply of water is afforded in an adjoining creek.

Washington Morgan, Esq., of Calhoun has presented

me with a fine polished specimen of black marble from his lands in Monroe county. The specimen is jet black with narrow white lines crossing each other at right angles, the squares being about an inch in diameter. It is without doubt, a continuation of the stratum noticed in the former pages, and which is the property of R. H. Armstrong, Esq., of Knoxville.

LEAD.

J. Winchester, Esq., of Charleston, Tennessee, informs me by letter, that he has discovered a fine locality of the argentiferous galena on the Cha-da-tee, a small stream which empties into the Hiwassee, near Charleston. He represents it as an outcrop, and says "it is beautiful—very pure, and occurs in a massive form. In every respect the ore is superior to that of the Wythe mines in Virginia."

Another very fine specimen of argentiferous lead ore has been handed me by Mr. Winston, of the East Tennessee & Virginia Road. It is doubtless from veins of the New Market ores. We can but believe that something yet will be derived from the development of the lead ores of East Tennessee.

LOOKOUT MOUNTAIN.

This mountain overlooking the city of Chattanooga, presents several striking peculiarities.

The strata of limestone in the vicinity of Chattanooga are found to dip, at an increasing angle as we go westward over the upturned edge, to the south-west. It will be remembered that the general stratification of East Tennessee is to the south-east. It is this dip which prevails directly east from this point as we approach Ducktown mines. At the base of Lookout mountain, as may be

noticed in the deep cut along the Railroad, the strata have a gentle dip to the south-east, so that between this point and Chattanooga is a short *synclinal* axis. It is a remarkable peculiarity in the general stratification of East Tennessee. This mountain itself stands as a monument of that mighty convulsion that took place which shook earth's huge pillars to their base. It rises as a towering cliff above the current of the Tennessee, the distance from the tressel work on the Railroad to the summit of the perpendicular cliff of sandstone being about two miles. Coming to a point, the northern extremity of the mountain is almost abrupt, but it gradually widens, as well as loses its altitude as it trends to the south-west. This cliff of sandstone, which caps the summit, is about 100 feet high and can only be scaled through crevices, and by means of slender trees and their roots which have grown into the scanty soil lodged there. The summit once gained, a grander and more imposing view can not be presented. At your feet, almost beneath you, flows the gentle Tennessee, here describing a curve, which, from its striking resemblance, the natives designated as *the moccasin*. There is Chattanooga, further up on the river lies Harrison, and the river itself may be traced out in its very serpentine windings at least 100 miles. The last that is seen of it, an elevated ridge has intercepted to obstruct its continuous view, but just beyond, it reposes like a calm silvery lake surrounded by elevated ridges. To the east rise in succession White Oak mountain, Frog mountain and the Unaka mountains, which are seen ranging to the north-east, as far as the eye can reach.

To the west, and near at hand, lies the Cumberland range, along whose eastern declivity the Tennessee rolls its flood of waters.

The sandstone which caps the mountain lies upon limestone of an oolitic structure, and along its edges and in front presents a bold and abrupt escarpment. From this sandstone doubtless blocks of various sizes have been detached as the soil has washed out beneath, and been precipitated into the vale below. One of these detached blocks lies near the tressel work on Chattanooga creek. It is about 160 feet in circumference, and from the point of the cliff, where it was originally attached, the several spots down the side of the mountain, where it struck as it fell and rebounded, may be readily traced out. The first spot where it struck, after it broke loose from its moorings, was near a spring, some six hundred yards from its bed. Thence it rebounded, striking again two hundred yards below, and so downwards striking and rebounding for five successive times until losing its momentum by opposing objects, it *slided*, ploughing a deep ravine, into its present bed, where it has probably remained for ages. What a terror and crash succeeded its fall! Ages have rolled by since its downward travel, for large trees are growing at each place where it struck and ploughed up the soil.

MINERAL WATERS.

From nearly every geological formation of the State, mineral springs are found to issue. They may be arranged into two different classes—*sulphureous* and *chalybeate*. We present a short sketch of those which have come more especially under our observation. The analyses appended are credited to those who made the examinations, but as a general thing they are imperfect. Many of these springs are fashionable resorts during the sultry summer months, and are supposed to possess medicinal virtues. From

the use of some of them we have known cases of chronic affections to be alleviated, if not permanently cured.

SULPHUREOUS SPRINGS.

These springs are characterized by the peculiar odor of the water, owing to the escape of sulphuretted hydrogen gas which has the odor of rotten eggs. These waters cause black precipitates with solutions of lead, silver, &c. Silver immersed in them soon become tarnished with a dark rusty coat. They also contain several saline substances as sulphate of soda and of magnesia, chloride of sodium and carbonates of soda and of magnesia.

NASHVILLE SULPHUR SPRING.

This noted spring has been a general place of resort from the first settlement of the country. The early pioneers here found herds of Buffalo and Deer which resorted hither to lick the salt left from the evaporation of the water.

It was originally styled the *French Lick*. In a time of scarcity the early pioneer evaporated the water in a rude trough, and gathered up the salt for use. It was represented as possessing a bitter taste, owing to the presence of compounds of magnesia. The water, on first use, acts gently on the bowels, but soon loses its effects. It is used by hundreds daily, of the citizens of Nashville, and it is much to be regretted that so valuable a spring cannot be so improved as to prevent its annual submersion beneath the waters of the Cumberland. It is situated in a basin which has evidently been the result of the constant resort to it from remote ages. The basin is surrounded by a dense growth of forest trees which it would

be sacrilege to destroy. The surrounding grounds, below high water mark of the Cumberland, are deposits of recent origin. To this point the wild savage repeatedly came, as near this spring are their mounds and burial grounds. The locality is interesting, historically as well as geologically—for here was the first resting place of the parties who went under General James Robertson, and Col. John Donelson in 1780 to settle the lands of the Cumberland. Here, near this spot in a cedar log cabin, was born, in 1781, the veteran physician of Nashville, Dr. Felix Robertson, the only survivor of those days of daring. He has seen Nashville in all its phases—from the log cabin to the marble palace—from the picketed fort to the massive towering capital—from the rude log school-house to the prosperous and thronged University.

The following general analysis was made by Prof. Bowen, formerly of the University of Nashville :

Sulphuretted hydrogen.
Carbonic acid.
Hydrochloric acid.
Sulphuric acid.
Magnesia as a sulphate.
Soda as muriate.

The foregoing analysis, according to our experiments, is thus combined :

Sulphuretted Hydrogen.
Carbonate of magnesia.
Chloride of sodium.
Sulphate of magnesia.

The quantitative analysis has never yet been determined.

CHALYBEATE SPRINGS.

In these waters, the principal or controlling ingredient is iron in some one of its forms. They have an inky or styptic taste, and by adding to them a solution of gallic or tannic acid, or an infusion of gall-nuts, they are changed

to a dark purple. The proto-salts of iron in these waters are distinguished from the sesqui-salts by the difference in the precipitates afforded with ferrocyanide of potassium. With the former, the proto-salts, this re-agent affords a white precipitate which becomes blue on exposure to the air; while with the latter, the sesqui-salts, gives it at once a blue precipitate, which changes red on adding the sulphocyanide of potassium.

MONTVALE SPRINGS, BLOUNT COUNTY.

Situated at the base of the Chilhowee mountains, 12 miles east of Maryville, in a well-shaded and romantic ravine, this celebrated watering-place attracts more than one thousand persons annually, to enjoy its quiet retreat and indulge its medicinal waters. There is not in Tennessee, more ample and more comfortable arrangements made for accommodating, as well the fashion and the careworn as the invalid, as is to be found here. Every variety of scenery is presented, to suit all tastes and inclinations. The student or the dejected may here plunge into the dense forest, and spend the hours in silent, unbroken meditation; the adventurous may scale the heights above, emerging, as it were, from a prison-house, and gaze once more upon the world around; the invalid, beneath the cool shades of the grove, can while away the hours in pleasant converse with refined associates, gathered together from all parts of the sunny South; and while quaffing of the exhilarating waters of the springs, dream of restored health, and a return in renewed vigor to his own hearthstone. Many have thus come, broken down under chronic affections of the stomach, liver and kidneys, and have gone away re-established in health. This is the Saratoga of the South—and in respect to location,

efficacy, and the cheerful company found there for the last half-dozen years, is unsurpassed in the State. The following analysis was made by Prof. J. B. Mitchell. One gallon of the water contains—

Chloride of sodium	1.96
Sulphate of soda	4.51
Sulphate of magnesia	12.00
Sulphate of lime	74.21
Carbonate of lime	13.26
Carbonate of iron	2.40
Loss	50
	108.84

So that it will be seen they are saline as well as chalybeate. Their effect upon the system is cathartic, if taken in excess, but slightly laxative in moderation; at the same time imparting tone to the system, and exciting gentle action of the perspiratory glands, and also the kidneys.

SHELBY CHALYBEATE SPRING, NASHVILLE.

Another saline and chalybeate spring, gushes forth from the east bank of Cumberland river, just at the base of the pier supporting the wire suspension bridge. The water is only accessible at low water in the river. Conveniences, by means of telegraph wires, are made for bringing up the water to the bridge, where hundreds daily resort during the summer, to partake of the cool draught. It is not so strongly chalybeate as to make it unpleasant; and when poured from glass to glass, sparkles from disengaged gas. An analysis of the spring, in 1852, yielded the following ingredients. Temperature of water 61°, air being at 90°:

Carbonic acid gas, free.
 Carbonate of iron.
 " magnesia.
 " lime.
 Chloride of sodium.
 Sulphate of magnesia.

It acts gently as a diuretic and diaphoretic, at same time imparting tone to the digestive organs.

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